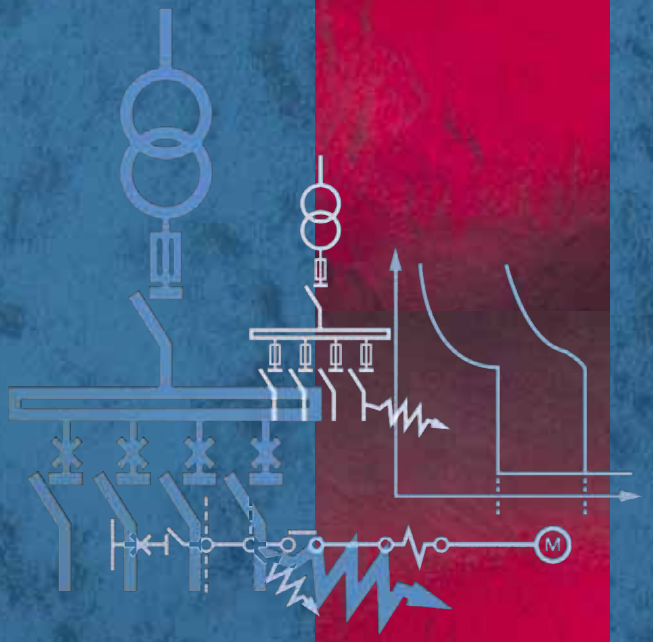
EATON | MEM

MEM Circuit Protection & Control

The Guide to Circuit Protection & Control

2003 Issue



Technical Support for
Electrical Installations

MEM

EATON | MEM

THE SOURCE OF CIRCUIT PROTECTION SOLUTIONS

As a market-leading manufacturer of circuit protection and control equipment, Eaton MEM's world leading switch and fusegear, circuit breaker and wiring accessory products are distributed across the globe.

Incorporating the latest technological advances, our products are the result of a comprehensive ongoing development programme and comply with the industry's most rigorous quality standards. This all serves to make Eaton MEM an industry benchmark, with unsurpassed quality and performance guaranteed.

This extensive product range, together with our lengthy experience and specialist knowledge serves to make Eaton MEM the only source for your installation needs.

Eaton Corporation is a global $7.2 billion diversified industrial manufacturer that is a leader in fluid power systems; electrical power quality, distribution and control; automotive engine air management and fuel economy; and intelligent drivetrain systems for fuel economy and safety in trucks. Eaton has 51,000 employees and sells products in more than 50 countries. For more information, visit www.eaton.com.

www.memonline.com

MEM

CONTENTS

EATON MEM IS UNIQUELY QUALIFIED TO OFFER AUTHORITATIVE GUIDANCE.

Eaton MEM offers designers a wide spectrum of protective devices available anywhere in the world from a single source - from packaged substations to final distribution; whether the installation is based on fuses, circuit breakers or a combination of both.

This guide is designed to provide essential information on HRC fuses, circuit breakers and motor control gear to designers, specifiers and installers of electrical installations. The characteristics, performance and benefits of each device are described with the requirements of the 16th Edition of the IEE Wiring Regulations (BS7671) in mind.

To make full use of the latest generation of Eaton MEM circuit protective devices the installation designer should ensure the suitability of the products for installation. To this end it is a requirement for the installation designer to determine the level of discrimination that is required and to take account of the need for back-up protection.

Using the information provided within this document will assist in the design of a safe and reliable system.

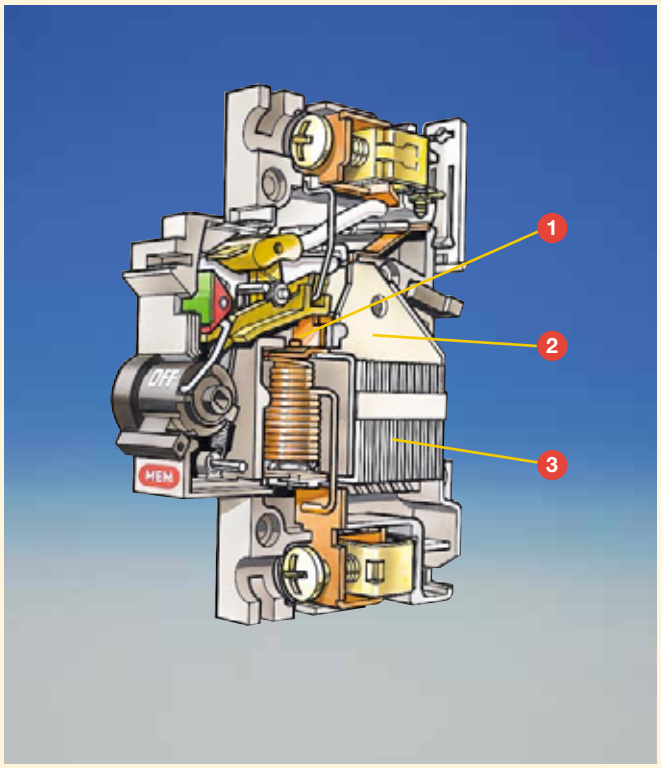
THE 16TH EDITION OF THE IEE WIRING REGULATIONS (BS7671) DEFINES A FUSE AS:

"A device that by the fusing of one or more of its specially designed and proportioned components, opens the circuit in which it is inserted by breaking the current when this exceeds a given value for a sufficient time. The fuse comprises all the parts that form the complete device."

A CIRCUIT BREAKER IS DEFINED AS:

"A device capable of making, carrying and breaking normal load currents and also making and automatically breaking under predetermined conditions, abnormal currents such as short-circuit currents. It is usually required to operate infrequently although some types are suitable for frequent operation."

MCB OPERATION



THERMAL OPERATION

The long time protection (typically 1 second after energising) of the MCB is defined as the thermal protection. The thermal component of the MCBs protection is dealt with by a bi-metal blade (in the case of Memshield 2 MCBs this is a multi-layer metallic blade which provides a more linear and accurate movement than a conventional bi-metallic blade).

When deflection of the bi-metal blade occurs, due to the heating effect of the overload current, it moves a trip lever which trips the latching mechanism and separates the main contacts under the action of a spring. The movement of the bi-metal blade is calibrated at manufacture to ensure correct performance in an ambient temperature of 40ºC. Memshield 2 MCBs conform to the tripping requirements of BSEN60898 as required by the wiring regulations for overload protection of cables between ambients of 20ºC and 40ºC. This means that the Memshield 2 MCB is calibrated to meet the higher ambient temperatures likely to be encountered when the MCBs are grouped together.

Therefore, it is unlikely that any derating of the MCB is necessary in normal use. 50ºC calibration is available.

Should further detailed information be required please contact our Technical Services Department at Reddings Lane.

MAGNETIC OPERATION

The short time protection (typically less than 1 second after energising) of the MCB is defined as the magnetic operation.

The magnetic component of the MCBs protection is dealt with by the electro-magnetic coil. The coil under heavy short circuit conditions creates an electro-magnetic field which causes the plunger 1 to force the contacts apart. In practice, at the maximum breaking capacity the contacts would be forced apart in less than one millisecond. The speed of this operation for Memshield 2 MCBs effectively prevents the contacts from welding.

When the contacts are forced apart by the action of a heavy short circuit a high intensity arc is produced between the contacts.

It is the control and rapid extinction of this arc that is a fundamental design advantage of Memshield 2 MCBs against zero point (half cycle) MCBs.

The resultant arc is moved extremely rapidly, under the influence of electro-magnetic forces between the deflector plates 2 and then into the arc stack 3 . The action of the arc stack ensures that the arc will be split into several smaller arcs thereby generating a very high arc voltage and quickly reducing the current to zero. At rated breaking capacity the total breaking operation will take approximately 6 milliseconds under the worst circumstances.

Memshield 2 MCBs are available with operating characteristics classified by BSEN60898 as below:-

TYPE NO.	OPERATION IS LESS THAN 100 MILLISECONDS (INSTANTANEOUS)
B	Between 3 and 5 times rated current
C	Between 5 and 10 times rated current
D	Between 10 and 20 times rated current

Circuit Breaker Protection

PROTECTION OF CABLES

PROTECTION OF CABLES IN ACCORDANCE WITH THE 16TH EDITION OF THE IEE WIRING REGULATIONS (BS 7671)

PROTECTION AGAINST OVERCURRENT:

Overcurrent is defined in the 16th Edition of the IEE Wiring Regulations as *"a current exceeding the rated value. For conductors the rated value is the current-carrying capacity."* Overcurrent can be divided into two individual levels of fault these being **overload current** and **short circuit current.** These should be considered separately.

PROTECTION AGAINST OVERLOAD:

Overload is defined in the 16th Edition of the IEE Wiring Regulations as *"an over current occurring in a circuit which is electrically sound"*. This may be the result of too many appliances drawing current from a system, a faulty appliance, or a motor subjected to mechanical overload. Regulation **433-01-01** of the 16th Edition of the IEE Wiring Regulations defines the basic requirement for overload protection, *"protective devices shall be provided to break an overload current flowing in the circuit conductors before such a current could cause a temperature rise detrimental to insulation, joints, terminations, or the surroundings of the conductors. Circuits shall be so designed that a small overload of long duration is unlikely to occur".*

CO-ORDINATION BETWEEN CONDUCTORS AND PROTECTIVE DEVICES:

It is apparent that Regulation **433-01-01** of the 16th Edition places emphasis on the surroundings of the conductor as well as the conductor itself. Regulation **433-02-01** has laid down three conditions to meet this requirement:

a) $I_b \leq I_n$

b) $I_n \leq I_z$

c) $I_2 \leq 1.45\ I_z$

Where I_b = design current of circuit

I_n = nominal current of protective device

I_z = current-carrying capacity of the cable

I_2 = minimum operating current of protective device

Miniature circuit breakers and moulded case circuit breakers normally have tripping factors of, or below this 1.45 figure so that if either of these devices is used in compliance with condition a) above will mean that condition b) is also met, thus providing overload protection to the conductors concerned.

PROTECTION AGAINST SHORT CIRCUIT:

Short circuit is defined in the 16th Edition of the IEE Wiring Regulations as: *"an overcurrent resulting from a fault of negligible impedance between live conductors having a difference in potential under normal operating conditions"*. IEE Wiring Regulation **434-03-02** states that: *"provided an overload protective device complies with regulation 433 and also provides short circuit protection the regulations are satisfied"* without need for further proof. This is because if **433-03-02** is satisfied then the cable and the overload rating of the device are compatible. However, where this condition is not met or in some doubt for example where a protective device is provided for fault current protection only, as in an MCCB backing up a motor overload relay then IEE Wiring Regulation **434-03-03** must be satisfied *"where a protective device is provided for fault protection only, the clearance time of the device, under short circuit conditions, shall not result in the limiting temperature of any conductors being exceeded."*

PROTECTION OF CABLES & CONDUCTORS AGAINST SHORT CIRCUITS:

Regulation **434-03-03** of the IEE Wiring Regulations takes account of the time by applying what is known as the adiabatic equation **434-03-03** states:

"The time 't' in which a given short circuit current will raise the temperature of the conductors to the limiting temperature, can be calculated from the formula":-

$$t = \frac{k^2 s^2}{I^2}$$

Where t = duration in secs
s = cable cross section (mm^2)
I = effective short circuit current (Amps)
k = a factor taking into account various criteria of the conductor

e.g. for a p.v.c. insulated copper conductor k = 115 (see Table 1) for a few of the k values quoted in the 16th Edition of the IEE Wiring Regulations.

TABLE 1

Values of k for common materials, for calculation of the effects of short circuit current.

CONDUCTOR MATERIAL	INSULATION MATERIAL	ASSUMED INITIAL TEMPERATURE °C	LIMITING FINAL TEMPERATURE °C	K
Copper	pvc	70	160/140	115/103
	60°C rubber	60	200	141
	85°C rubber	85	220	134
	90°C thermosetting	90	250	143
	Impregnated paper	80	160	108
	Mineral – exposed	70	160	115
	– not exposed	105	250	135
Aluminium	pvc	70	160/140	76/68
	60°C rubber	60	200	93
	85°C rubber	85	220	89
	90°C thermosetting	90	250	94
	Impregnated paper	80	160	71

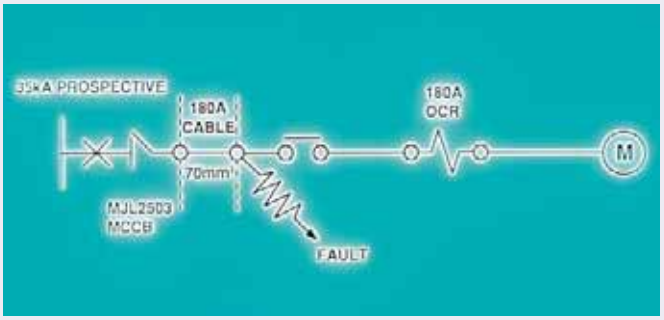
NOTE: Where two values of limiting final temperature and of k are given the lower value relates to cables having conductors of greater than $300mm^2$ cross-sectional area.

Therefore if the circuit breaker protecting the cable operates in less time than that required for the cable to reach its temperature limit the cable is protected (see example 1, case A).

Assessment of protection under short circuit condition when based on the adiabatic equation is only accurate for faults of short duration e.g. less than 0.1 seconds as the equation assumes no heat loss from the cable.

IEE Wiring Regulation **434-03-03** also states that for a short circuit of duration less than 0.1 seconds, where the asymmetry of the current is of importance the value of $k^2 s^2$ for the cable should be greater than the energy let through (I^2t) of the short circuit protective device (see example 1, case B).

EXAMPLE 1



CASE A

Fault current I = say 2800A

$$t = \frac{k^2 s^2}{I^2} = \frac{115^2 \times 70^2}{2800^2} = 8.27 \text{ secs}$$

Trip time of 250A MCCB = 0.3 secs.

CASE B

Fault current I = say 35,000A

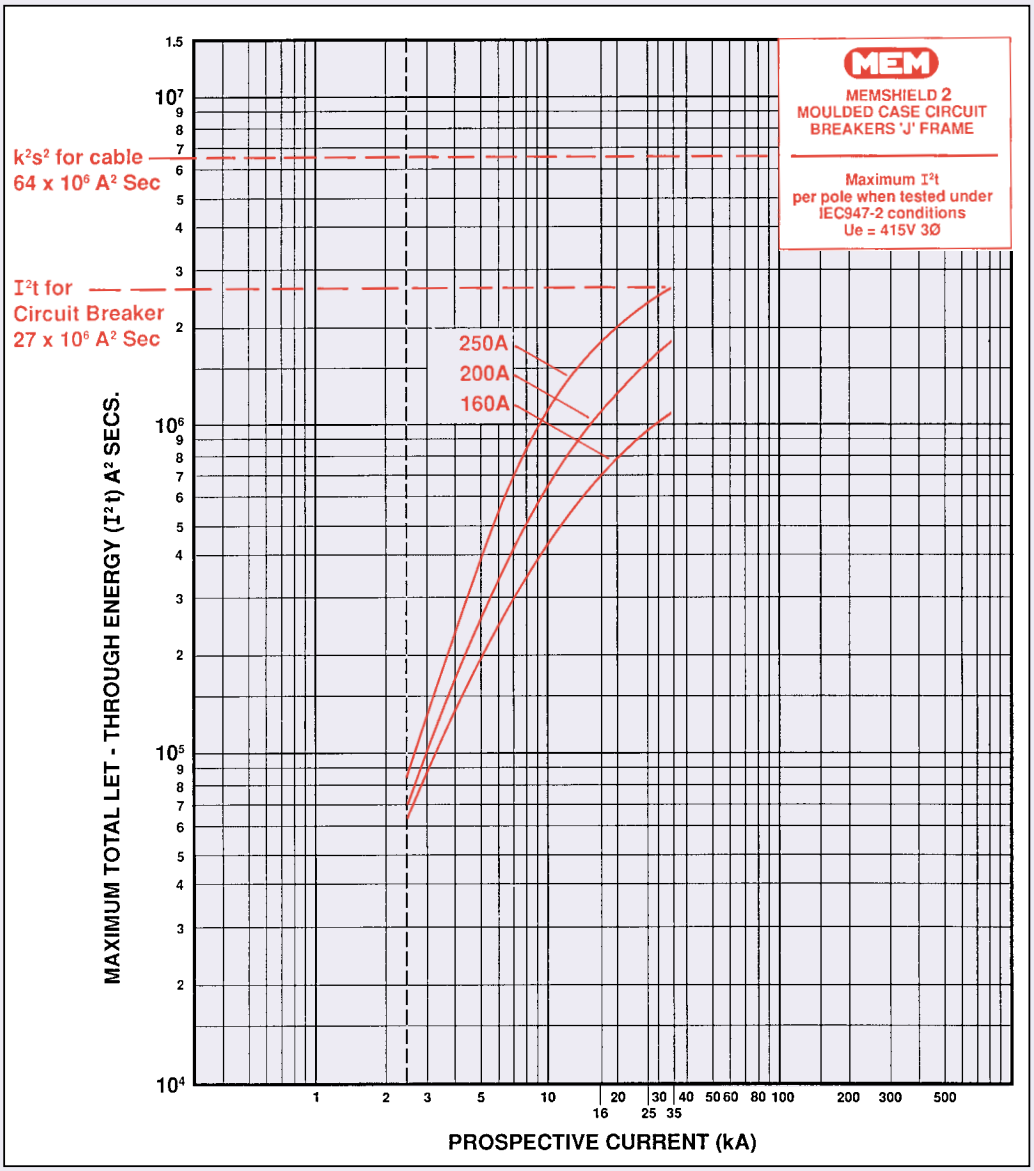
$k^2 s^2 = 115^2 \times 70^2$

$= 64 \times 10^6 A^2 \text{ secs}$

I^2t let-through of MJLA2503 MCCB

$I^2t = 27 \times 10^6 A^2 \text{ secs}$

FIGURE 1



Plot the $k^2 s^2$ value for 70mm² p.v.c. insulated copper cable, onto the total energy curve and ensure that the total I^2t at the chosen prospective fault is lower for the circuit breaker. Therefore the cable is protected as the breaker trips quicker than the time it takes for the cable to reach its limiting temperature and the k^2s^2 for the cable is higher than the I^2t for the circuit breaker (see fig.1).

MEMSHIELD 2 Circuit Breakers

Types of Discrimination

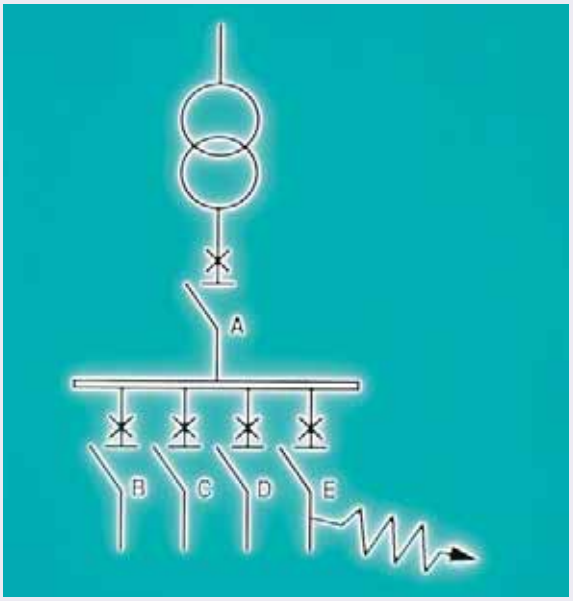
DISCRIMINATION:

The 16th Edition of the IEE Wiring Regulations (BS7671) **533-01-06** requires that in an installation: *"The characteristics and settings of devices for overcurrent protection shall be such that any intended discrimination in their operation is achieved"*.

Whether fuses or circuit breakers are utilised in a distribution system it is necessary to ensure that all the requirements of the 16th Edition of the IEE Wiring Regulations are complied with.

Discrimination, also called selectivity, is considered to be achieved when, under fault conditions the circuit breaker nearest the fault operates rather than any of the circuit breakers or fuses upstream of it (see example 2).

EXAMPLE 2



CONCEPT

Short circuit occurs at E

– "A" remains fully closed.
– "E" trips only, ensuring supply to B, C and D.

The discrimination of circuit breakers can be based on either magnitude of fault (current discrimination) or the duration of the time during which the circuit breaker "sees" the fault current (time discrimination).

Current Discrimination in a distribution system requires a circuit breaker to have a lower continuous current rating and a lower instantaneous pick-up value than the next upstream circuit breaker. Current discrimination increases as the difference between continuous current ratings increases and as pick-up settings increase between the upstream and downstream breakers.

Time Discrimination in a distribution system requires the use, upstream, of circuit breakers with adjustable time delay settings. The upstream breakers must be capable of withstanding the thermal and electrodynamic effects of the full prospective fault current during the time delay.

OVERLOAD DISCRIMINATION:

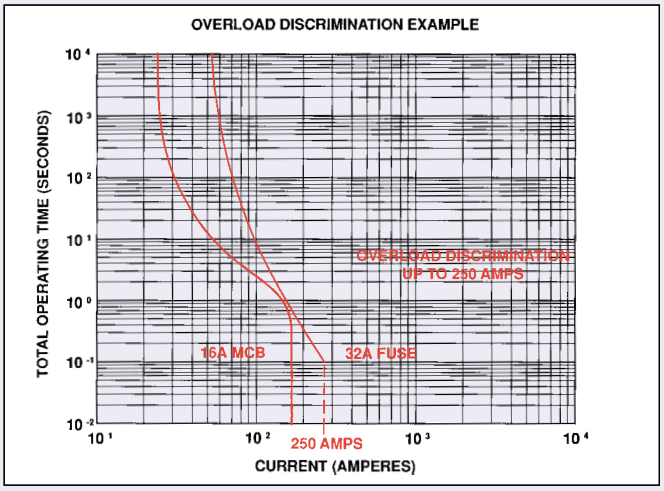
Time/Current discrimination at overload levels for products listed in chart 1.

CHART 1

UPSTREAM	DOWNSTREAM
BS88 Fuse	**Moulded case or miniature circuit breaker**
Moulded case or miniature circuit breaker	**Moulded case or miniature circuit breaker**

At overload levels a comparison of the device time/current characteristic curves (see fig 2) will show whether discrimination is achieved and if so the maximum value of fault current to which discrimination is achieved.

FIGURE 2



EXAMPLE 3

A 32SB3 Eaton MEM HRC fuse curve clears the 'knee' of a MCH116 Memshield 2 MCB curve and therefore will discriminate. The level to which discrimination is achieved is 250 amps derived by constructing a line from the end of the fuse curve (0.1 sec current) or as in Fig. 3 where the fuse curve crosses the MCB curve. Fig 3 shows that a 25 Amp fuse and a 16 Amp MCB downstream only discriminate up to 95A.

To save time all Eaton MEM fuse/circuit breaker combinations have been calculated; see Table 5 on page 13.

FIGURE 3

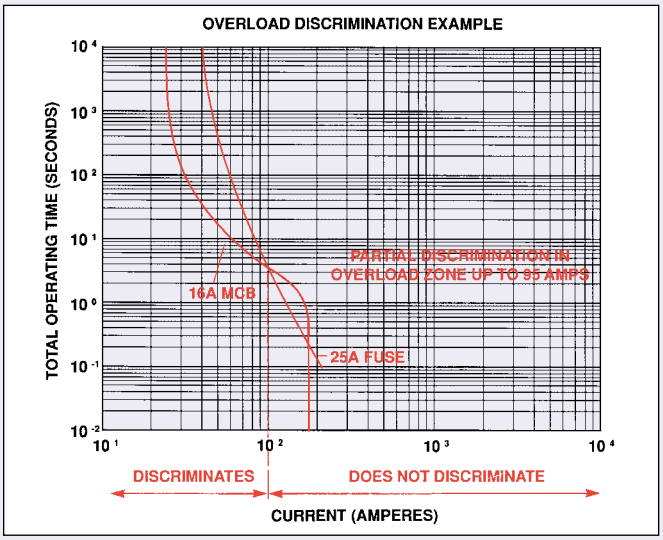
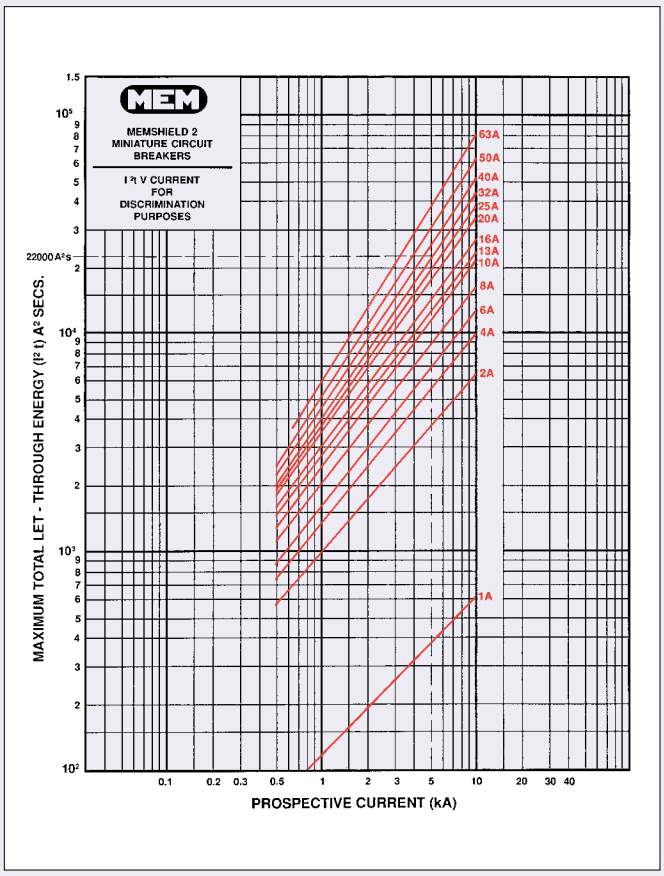


FIGURE 4



Short Circuit Discrimination: Current discrimination at short circuit levels for products in chart 2.

CHART 2

UPSTREAM	DOWNSTREAM
BS88 Fuse	**Moulded case or miniature circuit breaker**

Where high prospective fault levels exist at the circuit breaker distribution point then discrimination at short circuit levels should be considered. This requires comparison of the devices total let through energy and pre-arcing energy for the prospective fault level concerned.

Discrimination will be obtained at all fault levels for the circuit breaker when its total let through energy (I^2t) is less than the pre-arcing energy (I^2t) of the fuse nearer the supply.

The information for Eaton MEMs BS88 HRC fuse range can be extracted from curves and is presented in tabular form (see table 2 on page 11). This can be compared with Memshield 2 miniature circuit breaker and moulded case circuit breaker total let through energy curves an example being Figure 4.

EXAMPLE 4

The total let through energy of a 32A Memshield 2 miniature circuit breaker experiencing a fault of 5kA will be 22000 A^2s (See Figure 4). Relating this value to the pre-arcing value of the upstream fuse (see table 2) it can be seen that the lowest rated fuse providing discrimination is the 125SF6, **as its pre-arcing energy is greater than the total let through energy of a 32A Memshield 2 MCB at 5kA ie.**

Fuse pre-arcing		**MCB Total let through**
Upstream		Downstream
29743A^2s	>	22000A^2s
Fuse		Circuit Breaker

Full discrimination is achieved at 5kA.

This has been calculated for every combination of Memshield 2 circuit breakers and Eaton MEM BS88 fuselinks – see Table 5 on page 13.

MEMSHIELD 2 Circuit Breakers

Types of Discrimination

SHORT CIRCUIT DISCRIMINATION:

Current discrimination at short circuit levels for products listed in chart 3.

CHART 3

UPSTREAM	DOWNSTREAM
Category A MCCB	Category A MCCB
Category A MCCB	MCB

Category A moulded case circuit breakers are defined in BSEN60947-2 (IEC 60947-2), summarised as follows:-

– Category "A" applies to circuit breakers not specifically intended for selectivity (discrimination) under short circuit conditions.

Discrimination is possible but not on a time basis. These are current limiting type moulded case circuit breakers and as such it is not possible to assess short circuit discrimination by overlapping time current curves. Discrimination in the overload portion of the time/current characteristic can be shown by overlapping the time current curves but to determine short circuit discrimination a different technique must be applied.

Discrimination between two circuit breakers both of category A current limiting type cannot be determined by comparing the individual I^2t figures of the circuit breakers. This is not possible because unlike fuses, circuit breakers have no "fixed" pre-arcing energy. The nearest equivalent is the delatching energy; the point at which the tripping mechanism starts to open and is past its "point of no return".

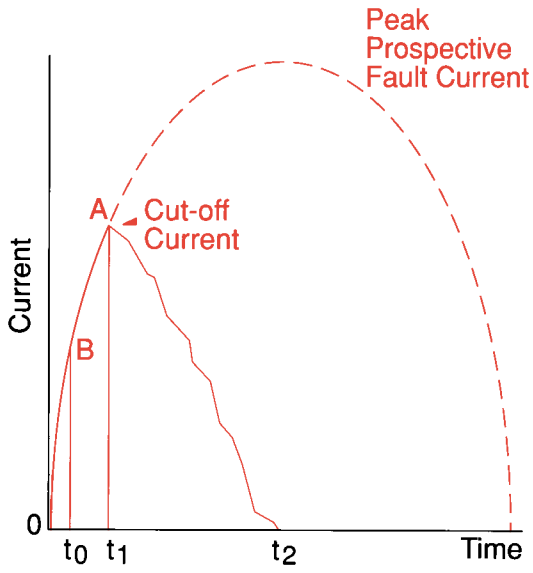
Figure 5 shows a typical fault current trace for a Memshield 2 current limiting MCB or MCCB. It can be seen that the delatch time (O-t_0) and hence the energy let through for that period, is considerably less than that for the period of time (O-t_2) that it takes to completely break the fault. Utilising the pre-arc energy – delatching energy analogy it is apparent that comparison between two current limiting Category A circuit breakers would represent less favourable results as the delatching I^2t energy would rarely be greater than the total let through energy of the downstream device.

Utilising the peak let-through current curve (Fig. 6) it is possible to extrapolate the level to which a current limiting circuit breaker will limit a prospective fault.

Examination of peak let-through current curves show a G frame Memshield 2 MCCB will limit a 11kA fault to 11kA peak ≡7.8kA RMS.

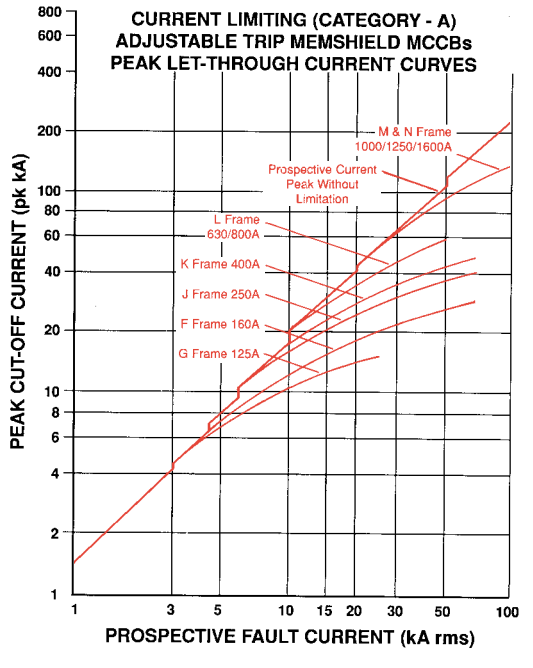
If the RMS equivalent value of the peak cut off current of the downstream circuit breaker is lower than the magnetic setting of the upstream circuit breaker then discrimination is assured. (See example 5).

FIGURE 5

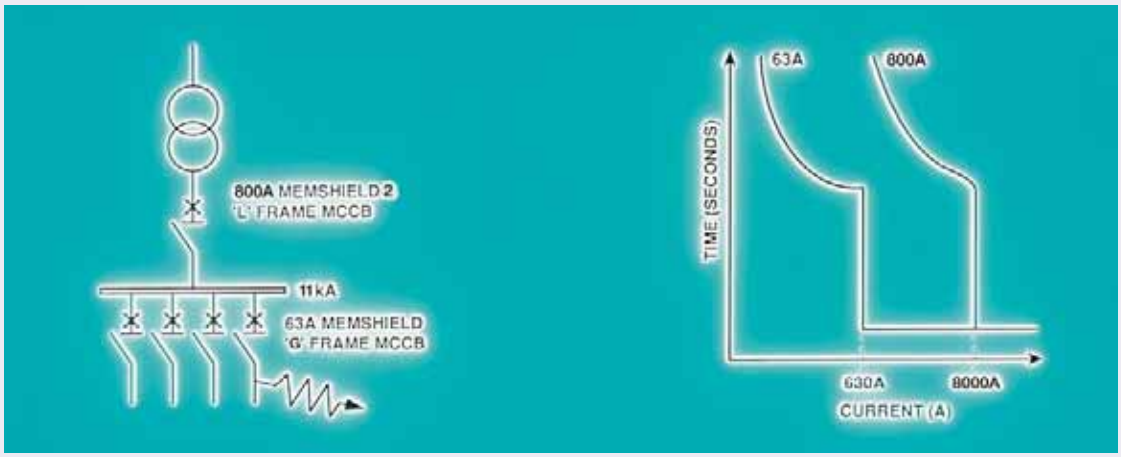


FAULT CURRENT TRACE
0 = Point of fault initiation.
t_0 = Contact opening time (i.e. creation of arc)
t_1 = Current / Voltage peak (i.e. current limitation).
t_2 = Time to total extinction of arc
(i.e. complete shutdown of fault current)

FIGURE 6



EXAMPLE 5



- *To save time all Eaton MEM circuit breaker / circuit breaker combinations have been calculated; see Table 3 on page 14.*

From the time current curve the discrimination level appears to be **8kA**.

Examination of peak let-through curves shows that 63A 'G' Frame Memshield 2 moulded case circuit breakers will limit a 11kA prospective fault to 11kA peak ≡ **7.8kA RMS**.

Therefore at 11kA the equivalent current let-through of the downstream breaker does not exceed the magnetic takeover level of the upstream breaker.

Peak let-through of downstream 63A 'G' frame = 7.8kA RMS < Magnetic takeover level of upstream 800A 'L' frame = 8.0kA RMS

This means we have a discriminating system to 11kA.

SHORT CIRCUIT DISCRIMINATION:

Time/Current discrimination at short circuit levels for products listed in chart 4.

CHART 4

UPSTREAM	DOWNSTREAM
Category B MCCB	Category A MCCB
Category B MCCB	Category B MCCB
BSS88 Fuse	Category B MCCB
Category B MCCB	MCB
Category B MCCB	BS88 Fuse

Category B moulded case circuit breakers are defined in BSEN60947-2 (IEC 60947-2), summarised as follows:-
– Category "B" applies to circuit breakers specifically intended for selectivity under short circuit conditions with respect to other short-circuit protective devices in series on the load side.

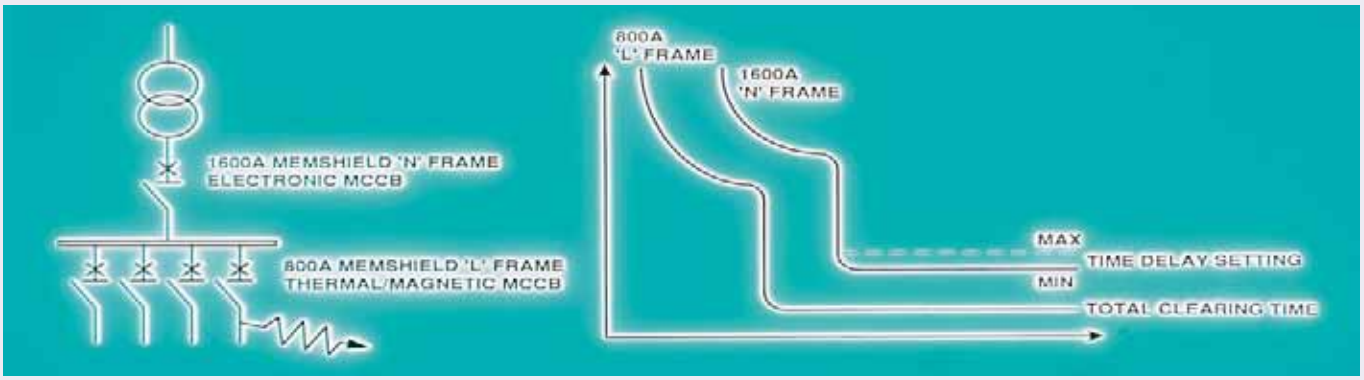
These circuit breakers are equipped with an intentional short time delay. This ensures that the upstream circuit breaker remains closed long enough under short circuit conditions to allow the downstream circuit protective device to clear the fault (see Fig 7).

In contrast with the current limiting category A type circuit breakers this type of circuit breaker is designed to withstand the rated short time withstand current (Icw) for the time duration dependent on the maximum time delay setting made on the circuit breaker.

MEMSHIELD 2 Circuit Breakers

Types of Discrimination & Back-up Protection

FIGURE 7



TIME DISCRIMINATION:

"The total clearing time of the downstream breaker must be less than the time delay setting of the upstream breaker".

The upstream circuit breaker must have a sufficient withstand capability for the thermal and electrodynamic effects of the full prospective short circuit.

To determine discrimination utilising an upstream category B moulded case breaker is relatively simple, it is only necessary to compare time/current characteristics with those of the down stream device and ensure that no overlap occurs.

To save time all Eaton MEM circuit breaker/circuit breaker combinations have been calculated; see Table 3 on page 14.

BACK-UP PROTECTION:

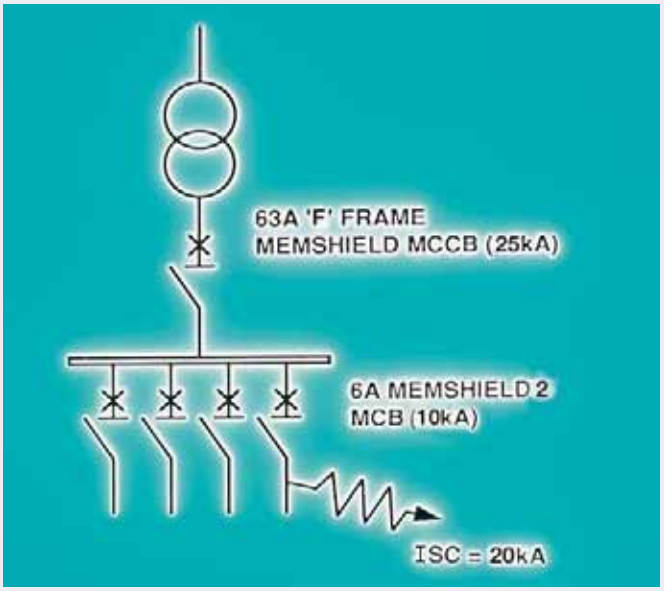
Back-up (Cascading) is recognised and permitted by the 16th Edition of the IEE Wiring Regulations (BS7671) **434-03-01.**

"A lower breaking capacity is permitted if another protective device having the necessary breaking capacity is installed on the supply side. In this situation, the characteristics of the device shall be co-ordinated such that the energy let through of these two devices does not exceed that which can be withstood without damage by the device on the load side and the conductors protected by these devices".

Back-up can be obtained with moulded case circuit breakers by the utilisation of the current limiting capacity of the upstream circuit breaker to permit the use of the lower breaking capacity and therefore lower cost downstream circuit breaker provided that the breaking capacity of the upstream circuit breaker is greater than or equal to the prospective short circuit current at its point of installation (see Fig 8).

In response to a short circuit fault the operation of the upstream circuit breaker creates an impedance which in conjunction with the impedance of the downstream device enables the downstream device to handle the short circuit potentially possible at its point of application.

FIGURE 8



EXAMPLE

By installing a Memshield 2 'F' frame MCCB (25kA breaking capacity) at the upstream end of the installation and with an Isc of 20k on the busbars it, is possible to install Memshield 2 Type B, C or D, characteristic 1 – 63A MCBs (10kA breaking capacity) on the outgoing lines.

To save time all Eaton MEM circuit breaker/circuit breaker or fused combinations have been calculated; see Table 4 on page 16.

TABLE 2

EATON MEM S-TYPE HRC FUSE-LINKS TO BS88: 1988 BSEN60269 PRE-ARCING AND TOTAL LET THROUGH ENERGY

FUSE TYPES	RATING (AMPERES)	415V FUSELINKS		550V FUSELINKS	
		I^2t PRE-ARCING	I^2t TOTAL @ 415 VOLTS	I^2t Pre-Arcing	I^2t TOTAL @ 550 VOLTS
SA2, SN2	2	2	4	2	5
	4	10	21	10	27
	6	34	74	34	95
	10	188	408	188	525
	16	92	412	92	672
	20	155	690	155	1120
	25	574	1810		*
	32	826	2610		*
SB3	2	2	4	2	5
	4	10	22	10	28
	6	34	75	34	97
	10	188	415	188	537
	16	207	696	207	1032
	20	367	1237	367	1835
	25	621	2090	621	3102
	32	1190	4006	1190	5947
SB4	40	2482	7019	2482	9842
	50	3305	9345	3305	13104
	63	5875	16612	5875	23296
SO	80	7800	26000		*
	100	14000	46000		*
SD5, SF5	80	7800	26000	7436	29825
	100	14000	75500	20655	82847
SD6, SF6	125	30000	75500	29743	133402
	160	58500	145000	46474	208441
	200	120000	300000	118973	533608
SF7, SG7	250	210000	530000	185895	675635
	315	270000	680000	267689	972915
SF8, SH8	355	365000	915000	364354	1594874
	400	480000	1200000	743580	3254846
SH9, SY9	450	755000	1900000	475891	1499588
	500	1100000	2700000	846029	2665934
	560	1200000	4000000	1070755	3374073
	630	1550000	5150000	1903565	5998352
SH10, SY10	710	1903565	4306813	1903565	5616995
	800	3820349	8643534	3820349	11272997
SP	16	90	300		*
	20	205	680		*
	25	575	1890		*
	32	825	2720		*
	40	1470	4840		*
	50	3300	10900		*
	63	5170	17000		*

*Max Rating 415 Volts

DETERMINATION OF PROSPECTIVE FAULT CURRENT

The following information is provided to assist with the calculation of Prospective Fault Current (assuming the voltage 415/240Vac).

Obtain the data:

(a) Transformer sc(kA) rating using the formula

$$\text{Short Circuit (kA)} = \frac{\text{kVA}}{\sqrt{3} \times 415} \times \frac{100}{\%\ \text{Reactance}}$$

or the data shown in Table A

(b) Cable sizes and lengths from transformer to the relevant point of installation.

Read off the added circuit resistance value (milliohms) from Table B for copper conductors.

Notes: (a) This applies for 3-phase symmetrical fault for a short circuit across all three phases.

(b) For single phase line-neutral faults, take the cable resistance and double (x2) the resistance to obtain the line-neutral value.

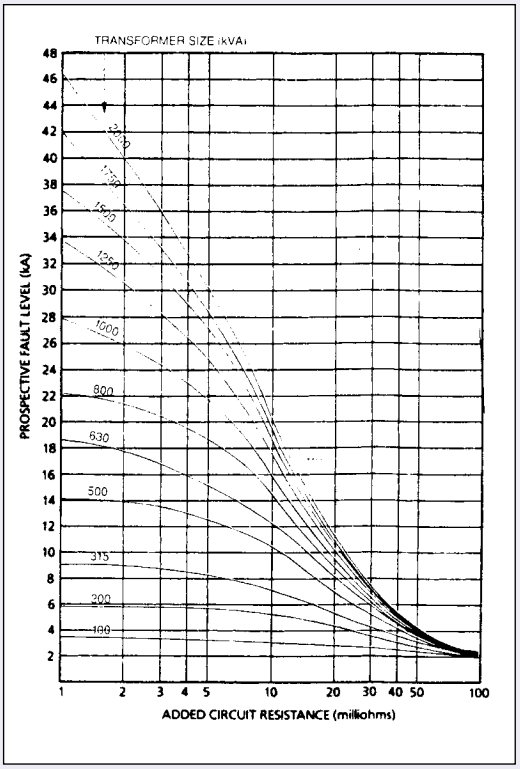
Knowing the resistance read off the prospective Fault Current from the graph.

TABLE A

kVA	% X	FLC (A)	SC (kA)
100	4.75	139	2.93
200	4.75	278	5.86
250	4.75	348	7.32
400	4.75	556	11.72
500	4.75	696	14.64
800	4.75	1113	23.43
1000	4.75	1391	29.29
1250	5	1739	34.78
1600	5.5	2226	40.47
2000	5.5	2782	50.59

TABLE B

Nominal Area mm²	Conductor strands/ dia.	Resistance in milli ohms of single-core cables of stated lengths (metres)												
		5	10	25	50	75	100	150	200	300	400	500	750	1000
1	1/1 - 13	86	177	442	885						When resistance values have been omitted for small conductors the fault level will be less than 0.25kA.			
1.5	1/1 - 38	60	119	297	595	892	1190							
2.5	1/1 - 78	36	71	159	357	515	714	1071						
4	7/0 - 85	23	45	113	226	339	452	678	904					
6	7/1 - 04	15	30	76	151	227	302	453	604	906	1208			
10	7/1 - 35	9	18	45	90	135	180	270	360	540	720	900		
16	7/1 - 70	6	11	28	57	85	113	170	226	339	452	565	847	1130
25	7/2 - 14	4	7	18	36	53	71	106	142	212	285	356	534	712
35	19/1 - 53	3	5	14	26	32	51	78	103	154	206	267	390	514
50	19/1 - 78	2	4	9	19	29	38	57	76	114	152	190	294	379
70	19/2 - 14	1	3	8	13	21	26	39	52	79	105	131	206	262
95	19/2 - 52		2	5	9	12	19	28	38	59	76	94	122	189
120	37/2 - 03		2	4	8	11	15	25	30	45	60	75	113	150
150	37/2 - 25		1	3	6	9	12	18	24	37	49	61	91	122
185	37/2 - 52			2	5	7	10	15	19	29	39	49	73	97
240	61/2 - 25			2	4	6	7	11	15	22	30	37	56	74
300	61/2 - 52			1	3	4	6	9	12	18	24	30	44	59
400	61/2 - 85			1	2	3	5	7	9	14	18	23	34	46
500	61/3 - 20				2	3	4	6	8	1	15	19	28	38
630	127/2 - 52				1	2	3	4	6	9	11	14	22	28
800	127/2 - 85				1	2	2	3	4	7	9	11	17	22
1000	127/3 - 20					1	2	3	4	5	7	9	13	18



Example: To calculate the prospective fault current at the end of 50m of 70mm² cable from a 1000kVA transformer.

Fault Current for 1000kVA Transformer = 29.29 kA

Read off the cable resistance for the copper conductors.

Resistance for 50m of 70mm² copper conductors = 13 milliohms

Knowing the resistance, read off short circuit current from graph using the 1000kVA curve.

From graph Short Circuit current = 13kA.

TABLE 5

CURRENT DISCRIMINATION – PROSPECTIVE FAULT LEVELS TO WHICH DISCRIMINATION IS ACHIEVED (A)
UPSTREAM: BS88 FUSE MEM SB3 TO SH10 – **DOWNSTREAM:** MEMSHIELD 2 TYPE B & C MCB TO MEMSHIELD 2 K FRAME MCCB

UPSTREAM →

FUSE RATING (A)		20	25	32	40	50	63	80	100	125	160	200	250	315	355	400	450	500	560	630	710	800
BREAKER RATING (A)																						
MEMSHIELD 2 MCB TYPE B & C	1	160	280	650	1600	2600	5400	7500	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
	2	160	280	650	1600	2600	5400	7500	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
	4	160	280	650	1600	2600	5400	7500	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
	6	160	280	650	1600	2600	5400	7500	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
	8		230	450	1000	1600	2700	3700	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
	10		230	450	1000	1600	2700	3700	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
	13			280	650	950	1800	2300	7000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
	16			280	650	950	1800	2300	7000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
	20				600	880	1750	2200	6100	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
	25					750	1500	1800	4600	6200	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
	32					750	1500	1800	4600	6200	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
	40						1200	1600	4000	5500	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
	50							1400	3400	4500	7000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
	63								500	3000	4250	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
MEMSHIELD 2 G FRAME MCCB	16				450	530	1600	1600	1600	1800	2300	4300	8000	14000	16000	16000	16000	16000	16000	16000	16000	16000
	20					550	1000	1000	1600	1800	2300	4300	8000	14000	16000	16000	16000	16000	16000	16000	16000	16000
	32							920	1600	1750	2200	4000	6000	8500	13250	16000	16000	16000	16000	16000	16000	16000
	40								1600	1750	2200	3700	5250	7500	11000	16000	16000	16000	16000	16000	16000	16000
	50									1700	2100	3500	4900	6700	9600	16000	16000	16000	16000	16000	16000	16000
	63									1700	2100	3500	4900	6700	9600	16000	16000	16000	16000	16000	16000	16000
	80											3250	4500	6000	8500	16000	16000	16000	16000	16000	16000	16000
	100											3250	4500	6000	8500	16000	16000	16000	16000	16000	16000	16000
	125													6000	8500	16000	16000	16000	16000	16000	16000	16000
MEMSHIELD 2 F FRAME MCCB	16				500	580	800	1000	1600	2200	2600	4800	8500	14500	25000	25000	25000	25000	25000	25000	25000	25000
	20				450	550	820	1000	1600	2200	2600	4800	8500	14500	25000	25000	25000	25000	25000	25000	25000	25000
	32							1000	1600	2200	2600	4700	7200	10000	14500	25000	25000	25000	25000	25000	25000	25000
	40								1600	2200	2600	4600	7000	9300	13000	25000	25000	25000	25000	25000	25000	25000
	50									2200	2600	4500	6800	8800	12000	23500	25000	25000	25000	25000	25000	25000
	63											4300	6800	8800	12000	23500	25000	25000	25000	25000	25000	25000
	80											4200	6000	8000	10000	22000	25000	25000	25000	25000	25000	25000
	100												6000	8000	10000	22000	23500	25000	25000	25000	25000	25000
	125													8000	10000	22000	23500	23500	25000	25000	25000	25000
	160														9500	18500	22000	22000	25000	25000	25000	25000
	200																					
MEMSHIELD 2 J FRAME MCCB	160															18000	22000	22000	32000	36000	36000	36000
	200																13000	13500	15000	35000	36000	36000
	250																		9700	17000	17000	36000
MEMSHIELD 2 K FRAME MCCB	250																	8100	9500	18000	18000	36000
	320																		9000	14000	14000	36000
	400																					36000

DOWNSTREAM →

= FULL DISCRIMINATION TO THE FAULT LEVEL OF THE DOWNSTREAM CIRCUIT BREAKER APPLIES FOR ALL MCB TYPES AND STANDARD RANGE MCCBs. HI-BREAK MCCBs WILL DISCRIMINATE TO AT LEAST THE LEVEL SHOWN.

TABLE 3

CURRENT DISCRIMINATION – PROSPECTIVE FAULT LEVELS TO WHICH DISCRIMINATION IS ACHIEVED (A)

UPSTREAM: Memshield 2 Type C MCB to Memshield 2 N Frame MCCB. **DOWNSTREAM:** Memshield 2 Type C MCB to Memshield 2 M Frame MCCB.

UPSTREAM →

DOWNSTREAM ↓

			MEMSHIELD 2 MCB														MEMSHIELD 2 G FRAME MCCB								
BREAKER RATING (A)			1	2	4	6	8	10	13	16	20	25	32	40	50	63	16	20	32	40	50	63	80	100	125
FAULT RATING		kA	10	10	10	10	10	10	10	10	10	10	10	10	10	10	16	16	16	16	16	16	16	16	16
BREAKER RATING (A)	1	10															7000	8000	8000	9000	9000	10000	10000	10000	10000
	2	10															7000	8000	8000	9000	9000	10000	10000	10000	10000
	4	10															7000	8000	8000	9000	9000	10000	10000	10000	10000
MEMSHIELD 2	6	10															7000	8000	8000	9000	9000	10000	10000	10000	10000
MCB	8	10																7000	7000	8000	8000	9000	9000	10000	10000
	10	10																7000	7000	8000	8000	9000	9000	10000	10000
	13	10																	7000	7000	8000	8000	9000	9000	10000
	16	10																	7000	7000	8000	8000	9000	9000	10000
	20	10																		7000	7000	8000	8000	9000	9000
	25	10																				5000	6000	6000	7000
	32	10																				5000	6000	6000	7000
	40	10																					5000	6000	6000
	50	10																						5000	5000
	63	10																							4000
MEMSHIELD 2	16	25																	320	400	500	630	800	1000	1250
G FRAME MCCB	20	25																	110	400	500	630	800	1000	1250
	32	25																		60	500	630	800	1000	1250
	40	25																			50	630	800	1000	1250
	50	25																				70	800	1000	1250
	63	25																					100	300	1250
	80	25																						110	1250
	100	25																							1000
	125	25																							
MEMSHIELD 2	16	25/45																							
F FRAME MCCB	20	25/45																							
	32	25/45																							
	40	25/45																							
	50	25/45/65																							
	63	25/45/65																							
	80	25/45/65																							
	100	25/45/65																							
	125	25/45/65																							
	160	25/45/65																							
	200	25/45/65																							
MEMSHIELD 2	200	36/65																							
J FRAME MCCB	250	36/65																							
MEMSHIELD 2	320	36/65																							
K FRAME MCCB	400	36/65																							
MEMSHIELD 2	630	50																							
L FRAME MCCB	800	50																							
MEMSHIELD 2	630	50																							
L FRAME (E) MCCB	500	50																							
MEMSHIELD 2	1000	65																							
M FRAME (E) MCCB	1250	65																							

(E) Indicates electronic type.

The discrimination data shown here is for guidance purposes only, utilising the specific Icu values of the MCCBs indicated.

MEMSHIELD 2 F FRAME MCCB											J FRAME		K FRAME		L FRAME		L FRAME (E)		M FRAME (E)		N (E) FRAME
16	20	32	40	50	63	80	100	125	160	200	200	250	320	400	630	800	630	800	1000	1250	1600
25	25	25	25	25	25	25	25	25	25	25	35	35	35	35	50	50	50	50	65	65	85
7000	8000	8000	9000	9000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
7000	8000	8000	9000	9000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
7000	8000	8000	9000	9000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
7000	8000	8000	9000	9000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
	7000	7000	8000	8000	9000	9000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
	7000	7000	8000	8000	9000	9000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
		7000	7000	8000	8000	9000	9000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
		7000	7000	8000	8000	9000	9000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
			7000	7000	8000	8000	9000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
					5000	6000	6000	10000	10000	8000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
					5000	6000	6000	10000	10000	8000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
						5000	6000	10000	10000	7000	10000	10000	10000	10000	10000	10000	10000*	10000*	10000*	10000*	10000*
							5000	10000	10000	6000	10000	10000	10000	10000	10000	10000	10000*	10000*	10000*	10000*	10000*
								10000	10000	5000	10000	10000	10000	10000	10000*	10000*	10000*	10000*	10000*	10000*	10000*
	75	320	400	500	630	800	1000	1250	1600	2000	2000	2500	3200	4000	11500	16000	16000	16000	16000	16000	16000
		150	400	500	630	800	1000	1250	1600	2000	2000	2500	3200	4000	11000	16000	16000	16000	16000	16000	16000
			150	500	630	800	1000	1250	1600	2000	2000	2500	3200	4000	10500	16000	16000	16000	16000	16000	16000
				200	630	800	1000	1250	1600	2000	2000	2500	3200	4000	10000	15500	16000	16000	16000	16000	16000
					400	800	1000	1250	1600	2000	2000	2500	2000	4000	9500	15000	16000	16000	16000	16000	16000
						500	1000	1250	1600	2000	2000	2500	2000	4000	9000	14500	16000	16000	16000	16000	16000
							620	1250	1600	2000	2000	2500	2000	4000	8500	14000	16000	16000	16000	16000	16000
								1250	1600	2000	2000	2500	2000	4000	8000	13500	16000	16000	16000	16000	16000
										1300	275	1000	800	4000	7500	13000	16000	16000	16000	16000	16000
		320	400	500	630	800	1000	1250	1600	2000	2000	6000	16000	16000	16000	16000	10000	12000	25000	25000	25000
		320	400	500	630	800	1000	1250	1600	2000	2000	6000	16000	16000	16000	16000	10000	12000	25000	25000	25000
				500	630	800	1000	1250	1600	2000	2000	6000	16000	16000	16000	16000	10000	12000	25000	25000	25000
					630	800	1000	1250	1600	2000	2000	6000	16000	16000	16000	16000	10000	12000	25000	25000	25000
						500	1000	1250	1600	2000	2000	6000	16000	16000	16000	16000	10000	12000	25000	25000	25000
							500	1250	1600	2000	2000	6000	16000	16000	16000	16000	10000	12000	25000	25000	25000
								1250	500	2000	2000	6000	16000	16000	16000	16000	10000	12000	25000	25000	25000
									200	2000	450	6000	16000	16000	16000	16000	10000	12000	25000	25000	25000
										600	270	6000	16000	16000	16000	16000	10000	12000	25000	25000	25000
												6000	16000	16000	16000	16000	10000	12000	25000	25000	25000
												350	500	16000	16000	16000	10000	12000	25000	25000	25000
													3000	4000	6000	7000	10000	14000	36000	36000	36000
													600	4000	6000	6000	10000	14000	36000	36000	36000
																	8000	10000	20000	20000	36000
																	8000	10000	20000	20000	36000
																			15000	15000	20000
																			15000	15000	20000
																				15000	20000
																				15000	20000

(E) Indicates electronic type.

Shaded area indicates full discrimination to the fault level of the downstream circuit breaker. *6000A for type D MCBs.

MEMSHIELD 2 Circuit Breakers

Prospective Fault Level to Which Backup is Achieved

TABLE 4

PROSPECTIVE FAULT LEVEL TO WHICH BACKUP IS ACHIEVED (kA)

UPSTREAM →

DOWNSTREAM ↓

		MEMSHIELD 2 G FRAME MCCB									MEMSHIELD 2 F FRAME MCCB										
BREAKER RATING (A)		16	20	32	40	50	63	80	100	125	16	20	32	40	50	63	80	100	125	160	200
FAULT RATING	kA	16/25	16/25	16/25	16/25	16/25	16/25	16/25	16/25	16/25	25	25	25	25	25	25	25	25	25	25	25
MCH301	10	16/20	16/20	16/20	16/20	16/20	16/20	16/20	16/20	16/20	22	22	22	22	22	22	22	22	22	22	20
MCH302	10	16/20	16/20	16/20	16/20	16/20	16/20	16/20	16/20	16/20	22	22	22	22	22	22	22	22	22	22	20
MCH304	10	16/20	16/20	16/20	16/20	16/20	16/20	16/20	16/20	16/20	22	22	22	22	22	22	22	22	22	22	20
MCH306	10	16/20	16/20	16/20	16/20	16/20	16/20	16/20	16/20	16/20	22	22	22	22	22	22	22	22	22	22	20
MCH308	10	16/20	16/20	16/20	16/20	16/20	16/20	16/20	16/20	16/20	22	22	22	22	22	22	22	22	22	22	20
MCH310	10	16/20	16/20	16/20	16/20	16/20	16/20	16/20	16/20	16/20	22	22	22	22	22	22	22	22	22	22	20
MCH313	10	16/20	16/20	16/20	16/20	16/20	16/20	16/20	16/20	16/20	22	22	22	22	22	22	22	22	22	22	20
MCH316	10	16/20	16/20	16/20	16/20	16/20	16/20	16/20	16/20	16/20	22	22	22	22	22	22	22	22	22	22	20
MCH320	10	16/20	16/20	16/20	16/20	16/20	16/20	16/20	16/20	16/20	22	22	22	22	22	22	22	22	22	22	20
MCH325	10	16/20	16/20	16/20	16/20	16/20	16/20	16/20	16/20	16/20	22	22	22	22	22	22	22	22	22	22	20
MCH332	10	16/20	16/20	16/20	16/20	16/20	16/20	16/20	16/20	16/20	22	22	22	22	22	22	22	22	22	22	20
MCH340	10	16/20	16/20	16/20	16/20	16/20	16/20	16/20	16/20	16/20	22	22	22	22	22	22	22	22	22	22	20
MCH350	10	16/20	16/20	16/20	16/20	16/20	16/20	16/20	16/20	16/20	22	22	22	22	22	22	22	22	22	22	20
MCH363	10	16/20	16/20	16/20	16/20	16/20	16/20	16/20	16/20	16/20	22	22	22	22	22	22	22	22	22	22	20
MGL163/MGH163	16/25										25	25	25	25	25	25	25	25	25	25	25
MGL203/MGH203	16/25										25	25	25	25	25	25	25	25	25	25	25
MGL323/MGH323	16/25										25	25	25	25	25	25	25	25	25	25	25
MGL403/MGH403	16/25										25	25	25	25	25	25	25	25	25	25	25
MGL503/MGH503	16/25										25	25	25	25	25	25	25	25	25	25	25
MGL633/MGH633	16/25										25	25	25	25	25	25	25	25	25	25	25
MGL803/MGH803	16/25										25	25	25	25	25	25	25	25	25	25	25
MGL1003/MGH1003	16/25										25	25	25	25	25	25	25	25	25	25	25
MGL1253/MGH1253	16/25										25	25	25	25	25	25	25	25	25	25	25
MFL163	25																				
MFL 203	25																				
MFL323	25																				
MFL403	25																				
MFL503	25																				
MFL633	25																				
MFL803	25																				
MFL1003	25																				
MFL1253	25																				
MFL1603	25																				
MFL2003	25																				
MJLA1603	35																				
MJLA2003	35																				
MJLA2503	35																				
MKLA2503	35																				
MKLA3203	35																				
MKLA4003	35																				
MLLA6303	50																				
MLLA8303	50																				

Hi-break F, J & K frame MCCBs may be backed up with HRC fuses to 80kA prospective fault level.

J FRAME			K FRAME		L FRAME		M FRAME (E)		N FRAME (E)	BS88 MAX FUSE					BS1361 MAX FUSE
160	200	250	320	400	630	800	1000	1250	1600	100	160	200	400	450	100
36	36	36	36	36	50	50	65	65	85	80	80	80	80	80	33
20	20	20								40	25	25			33
20	20	20								40	25	25			33
20	20	20								40	25	25			33
20	20	20								40	25	25			33
20	20	20								40	25	25			33
20	20	20								40	25	25			33
20	20	20								40	25	25			33
20	20	20								50	40	25			33
20	20	20								50	40	25			33
20	20	20								50	40	25			33
20	20	20								50	40	25			33
20	20	20								50	40	25			33
20	20	20								50	40				33
20	20	20								50	40				33
36	36	36	36	36						80	80	80	80		
36	36	36	36	36						80	80	80	80		
36	36	36	36	36							80	80	80		
36	36	36	36	36						80	80	80	80		
36	36	36	36	36						80	80	80	80		
36	36	36	36	36						80	80	80	80		
35	35	35	35	36							80	80	80		
36	36	36	36	36							80	80	80		
36	36	36	36	36							80	80	80		
36	36	36	36	36	50	50				80	80	80	80		
36	36	36	36	36	50	50				80	80	80	80		
36	36	36	36	36	50	50				80	80	80	80		
36	36	36	36	36	50	50				80	80	80	80		
36	36	36	36	36	50	50				80	80	80	80	80	
36	36	36	36	36	50	50				80	80	80	80	80	
36	36	36	36	36	50	50				80	80	80	80	80	
36	36	36	36	36	50	50				80	80	80	80	80	
36	36	36	36	36	50	50					80	80	80	80	
	36	36	36	36	50	50					80	80	80	80	
		36	36	36	50	50						80	80	80	
		36	36	36	50	50						80	80	80	
		36	36	36	50	50						80	80	80	
	36	36	36	50	50							80	80		
			36	36	50	50							80	80	
				36	50	50							80	80	
					50	50							80	80	
								65	85						
								65	85						

(E) Indicates electronic Type

THERMAL DE-RATING OF CIRCUIT BREAKERS

Thermal de-rating is primarily for environments which create a different ambient temperature. This could be due to temperature variants e.g. Scandinavia, where a re-rating factor is applied or the Middle East where a de-rating factor is applied, close proximity to other warmer operating products and small high IP rated enclosures may also increase the ambient temperatures.

Memshield 2 – MCBs & RBCOs. Types:- B, C, D.

CURRENT RATING (AMPS) @40°C	DEVICE RATING (AMPS) @40°C	@55°C	@60°C
6	6.0	5.4	5.1
10	10.0	9.0	8.5
16	16.0	14.4	13.6
20	20.0	18.0	17.0
32	32.0	28.8	27.2
40	40.0	36.0	34.0
50	50.0	45.0	42.5
63	63.0	56.7	53.6

Memshield 2 MCBs are calibrated at an ambient temperature of 40°C. 50°C calibrated units are available without de-rating.

Memshield 2 – G Frame MCCBs. Types:- MGL, MGH, MGHAT.

CURRENT RATING (AMPS) @40°C	DEVICE RATING (AMPS) @20°C	@30°C	@40°C	@50°C	@60°C
16	19.2	17.6	16.0	14.4	13.0
20	24.0	22.0	20.0	18.0	16.6
32	38.4	35.2	32.0	28.8	26.5
40	48.0	44.0	40.0	36.0	33.2
50	60.0	55.0	50.0	45.0	41.2
63	75.6	69.3	63.0	56.7	52.0
80	96.0	88.0	80.0	72.0	66.0
100	120.0	110.0	100.0	90.0	83.0
125	150.0	137.5	125.0	112.5	104.0

Memshield 2 – Fixed Trip F Frame MCCBs. Types:- MFL, MFH.

CURRENT RATING (AMPS) @40°C	DEVICE RATING (AMPS) @20°C	@30°C	@40°C	@50°C	@60°C
16	19.4	17.8	16.0	14.9	13.6
20	24.2	22.2	20.0	18.6	17.0
32	38.7	35.5	32.0	29.8	27.2
40	48.4	44.4	40.0	37.2	34.0
50	60.5	55.5	50.0	46.5	42.5
63	76.2	69.9	63.0	58.6	53.6
80	96.8	88.8	80.0	74.4	68.0
100	121.0	111.0	100.0	93.0	85.0
125	151.3	138.8	125.0	116.3	106.3
160	193.6	177.6	160.0	148.8	136.0
200	242.0	222.0	200.0	186.0	170.0

Memshield 2 – Adjustable Trip F Frame MCCBs. Types:- MFLA, MFHA.

CURRENT RATING (AMPS) @40°C	DEVICE RATING (AMPS) @20°C	@30°C	@40°C	@50°C	@60°C
50	50.0	50.0	50.0	47.0	44.0
63	63.0	63.0	63.0	59.0	55.0
80	80.0	80.0	80.0	75.0	70.0
100	100.0	100.0	100.0	93.0	88.0
125	125.0	125.0	125.0	117.0	109.0
160	160.0	160.0	160.0	150.0	140.0

NOTE: Adjustable trip F Frame MCCBs require no ambient temp compensation between -5 to +40°C.

Memshield 2 – J & K Frame MCCBs. Types:- MJLA, MJHA, MKLA, MKHA.

CURRENT RATING (AMPS) @40°C	DEVICE RATING (AMPS) @20°C	@30°C	@40°C	@50°C	@60°C
160	160.0	160.0	160.0	150.0	141.0
200	200.0	200.0	200.0	188.0	176.0
250	250.0	250.0	250.0	235.0	220.0
320	320.0	320.0	320.0	304.0	288.0
400	400.0	400.0	400.0	380.0	360.0

NOTE: J & K Frame MCCBs require no ambient temp compensation between -5 to +40°C.

Memshield 2 – L Frame MCCBs. Types:- MLLA.

CURRENT RATING (AMPS) @40°C	DEVICE RATING (AMPS) @20°C	@30°C	@40°C	@50°C	@60°C
400	444.0	424.0	400.0	376.0	350.0
630	699.0	668.0	630.0	590.0	550.0
800	888.0	848.0	800.0	750.0	700.0

Memshield 2 – L Frame MCCBs. Types:- MLLS.

CURRENT RATING (AMPS) @40°C	DEVICE RATING (AMPS) @20°C	@30°C	@40°C	@50°C	@60°C
630	630.0	630.0	630.0	600.0	480.0
800	800.0	800.0	800.0	720.0	608.0

Memshield 2 – M & N Frame MCCBs. Types:- MMLS, MNLS (F & R connection).

CURRENT RATING (AMPS) @40°C	DEVICE RATING (AMPS) @20°C	@30°C	@40°C	@50°C	@60°C
1000	1000.0	1000.0	1000.0	1000.0	950.0
1250	1250.0	1250.0	1250.0	1125.0	950.0
1600	1600.0	1600.0	1600.0	1440.0	1216.0

MEMSHIELD 2 Circuit Breakers

Protecting Lighting Circuits with Memshield 2 MCBs

The following tables show the maximum number of light fittings which will be adequately protected by Memshield 2 Type C MCBs.

FLUORESCENT LAMPS

Number of fittings per pole

LAMP (W)	BALLAST TYPE	CONNECTION	MCB RATING (A) - TYPE C													
			1	2	4	6	8	10	13	16	20	25	32	40	50	63
4	switchstart	non-compensated	5	11	23	35	47	58	76	94	117	147	188	235	294	370
		compensated	1	2	5	8	11	14	19	23	29	36	47	58	73	92
2 x 4	switchstart	non-compensated	2	5	11	17	23	29	38	47	58	73	94	117	147	185
		compensated	1	2	5	8	11	14	19	23	29	36	47	58	73	92
6	switchstart	non-compensated	6	13	26	40	53	66	86	106	133	166	213	266	333	420
		compensated	1	3	6	10	13	16	21	26	33	41	53	66	83	105
2 x 6	switchstart	non-compensated	3	6	13	20	26	33	43	53	66	83	106	133	166	210
		compensated	1	3	6	10	13	16	21	26	33	41	53	66	83	105
8	switchstart	non-compensated	6	13	26	40	53	66	86	106	133	166	213	266	333	420
		compensated	1	3	6	10	13	16	21	26	33	41	53	66	83	105
2 x 8	switchstart	non-compensated	3	6	13	20	26	33	43	53	66	83	106	133	166	210
		compensated	1	3	6	10	13	16	21	26	33	41	53	66	83	105
13	switchstart	non-compensated	5	11	23	35	47	58	76	94	117	147	188	235	294	370
		compensated	1	2	5	8	11	14	19	23	29	36	47	58	73	92
15	switchstart	non-compensated	8	16	33	50	66	83	108	133	166	208	266	333	416	525
		compensated	2	3	8	12	16	20	27	33	41	52	66	83	104	131
2 x 15	switchstart	non-compensated	4	8	16	25	33	41	54	66	83	104	133	166	208	262
		compensated	2	3	8	12	16	20	27	33	41	52	66	83	104	131
18	switchstart	non-compensated	7	15	30	46	61	76	100	123	153	192	246	307	384	484
		compensated	1	3	7	11	15	19	25	30	38	48	61	76	96	121
2 x 18	switchstart	non-compensated	3	7	15	23	30	38	50	61	76	96	123	153	192	242
		compensated	1	3	7	11	15	19	25	30	38	48	61	76	96	121
4 x 18	switchstart	non-compensated	1	3	7	11	15	19	25	30	38	48	61	76	96	121
		compensated	1	3	7	11	15	19	25	30	38	48	61	76	96	121
30	switchstart	non-compensated	5	11	22	33	44	55	72	88	111	138	177	222	277	350
		compensated	1	2	5	8	11	13	18	22	27	34	44	55	69	87
36	switchstart	non-compensated	4	9	18	27	36	45	59	72	90	113	145	181	227	286
		compensated	1	2	4	6	9	11	14	18	22	28	36	45	56	71
2 x 36	switchstart	non-compensated	2	4	9	13	18	22	29	36	45	56	72	90	113	143
		compensated	1	2	4	6	9	11	14	18	22	28	36	45	56	71
58	switchstart	non-compensated	2	5	11	17	23	29	38	47	58	73	94	117	147	185
		compensated	0	1	2	4	5	7	9	11	14	18	23	29	36	46
2 x 58	switchstart	non-compensated	1	2	5	8	11	14	19	23	29	36	47	58	73	92
		compensated	0	1	2	4	5	7	9	11	14	18	23	29	36	46
70	switchstart	non-compensated	2	5	10	15	21	26	34	42	52	65	84	105	131	165
		compensated	0	1	2	3	5	6	8	10	13	16	21	26	32	41
2 x 70	switchstart	non-compensated	1	2	5	7	10	13	17	21	26	32	42	52	65	82
		compensated	0	1	2	3	5	6	8	10	13	16	21	26	32	41
100	switchstart	non-compensated	1	3	7	11	15	19	25	31	39	49	62	78	98	123
		compensated	0	0	1	2	3	4	6	7	9	12	15	19	24	30
125	switchstart	non-compensated	1	2	4	6	8	10	13	17	21	26	34	42	53	67
		compensated	0	0	1	1	2	2	3	4	5	6	8	10	13	16

Please contact us for Electronic Ballasts (HF)

DISCHARGE LAMPS

Number of fittings per pole

LAMP TYPE	LAMP (W)	MCB RATING (A) - TYPE C													
		1	2	4	6	8	10	13	16	20	25	32	40	50	63
MBF															
	50	0	1	3	5	6	8	10	13	16	20	26	33	41	52
	80	0	1	2	3	4	5	6	8	10	12	16	20	25	31
	125	0	0	1	2	2	3	4	5	7	8	11	14	17	22
	250	0	0	0	1	1	1	2	3	3	4	6	7	9	12
	400	0	0	0	0	0	1	1	1	2	2	3	4	5	7
	700	0	0	0	0	0	0	0	1	1	1	2	2	3	4
MBI															
	150	0	0	1	1	2	3	4	5	6	7	10	12	15	19
	250	0	0	0	1	1	1	2	3	3	4	6	7	9	12
	400	0	0	0	0	1	1	1	2	2	3	4	5	6	7
	750	0	0	0	0	0	0	0	0	1	1	1	2	3	3
SON															
	50	0	1	3	5	6	8	10	13	16	20	26	33	41	52
	70	0	1	2	3	5	6	8	10	12	15	20	25	31	39
	100	0	1	2	3	4	5	6	8	10	12	16	20	25	31
	150	0	0	1	1	2	3	4	5	6	7	10	12	15	19
	250	0	0	0	1	1	1	2	3	3	4	6	7	9	12
	400	0	0	0	0	0	1	1	1	2	2	3	4	5	7
	1000	0	0	0	0	0	0	0	0	0	1	1	1	2	2
SOX															
	18	1	3	7	11	15	19	24	30	38	48	61	76	96	121
	35	0	1	3	5	7	9	12	15	19	24	30	38	48	60
	55	0	1	3	4	6	7	10	12	15	19	25	31	39	49
	90	0	1	2	3	4	5	6	8	10	12	16	20	25	31
	135	0	0	1	1	2	2	3	4	5	7	9	11	14	18

Eaton MEM's Memshield 2 range of MCB's and MCCB's are suitable to operate on DC.

SELECTING THE CORRECT CIRCUIT BREAKER

In order to select the correct circuit breaker for use on DC, a number of factors need to be considered.

RATED CURRENT:

This will determine the current rating of the circuit breaker, however the Time/Current characteristic will differ to that used on AC applications.

THERMAL:

Remains unaffected, temperature de-rating values will remain the same as AC.

MAGNETIC:

Becomes less sensitive (trip level increases by 41%).

SYSTEM VOLTAGE:

The system voltage as well as the type of system determine the number of poles in series required to provide the necessary breaking capacity.

SHORT CIRCUIT CURRENT:

This is the maximum short circuit current at the point of installation, used to determine the breaking capacity required.

CALCULATION OF SHORT CIRCUIT CURRENT, BATTERY SYSTEMS: Isc = Vb/Ri

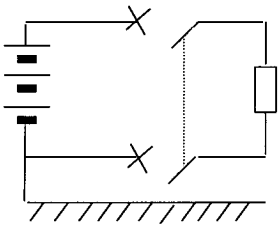
Isc is the value of short circuit current. Vb is the maximum discharge voltage (battery 100% charged). Ri is the internal resistance (given by the battery manufacturer).

SELECTION TABLE FOR D.C. SYSTEMS

BREAKING CAPACITY kA & (NO. POLES IN SERIES)				
	24V	60V	120V	250V
Type B	6 (1)		4 (1)	
Type C	6 (1)		4 (1)	
Type D	6 (1)		4 (1)	
G - Frame				20 (3)
F - Frame				38 (3)
J - Frame				38 (3)
K - Frame				38 (3)
L - Frame (t/m)				40 (3)

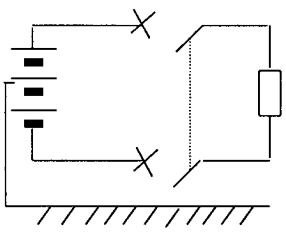
TYPE OF DC SYSTEMS: 3 DIFFERENT TYPES

One polarity earthed (either +ve or -ve)



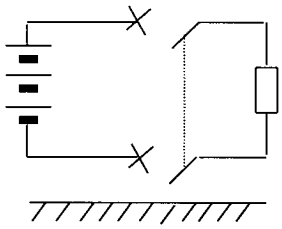
If the -ve is earthed, all poles will be placed in series in the +ve leg.
If the +ve is earthed, all poles will be placed in the -ve leg.
NOTE: an extra pole will be needed on the earthed polarity to provide isolation.

Middle point earthed

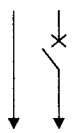


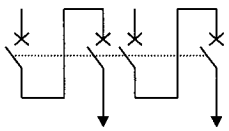
The number of poles required to break Isc should be placed on each polarity.

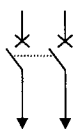
Insulated from earth



The number of poles required to break Isc should be split between the two polarities.







CIRCUIT BREAKER SELECTION CHARTS FOR SELECTIVITY WITH DIRECT-ON-LINE AND STAR-DELTA STARTERS

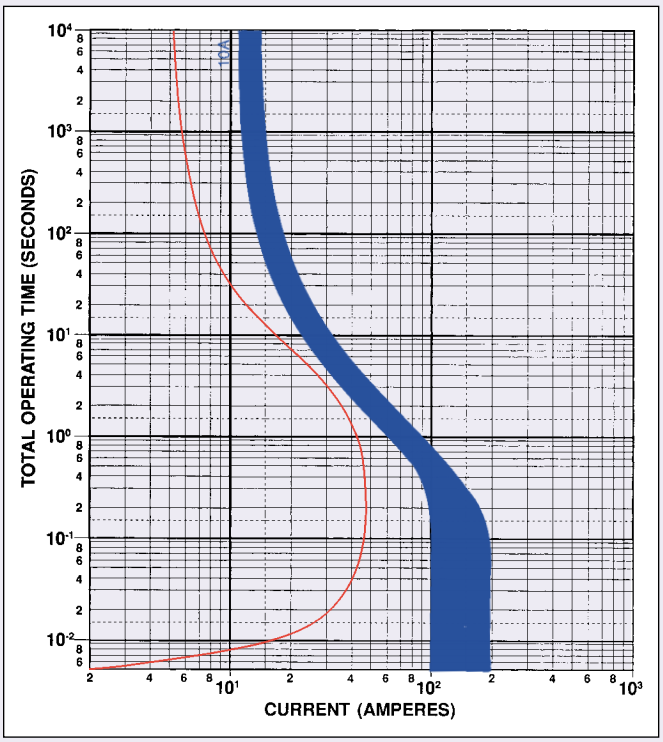
DIRECT-ON-LINE

Typically direct-on-line (d.o.l.) starting will create a start-up current inrush of 6 - 8 x full load current. In addition this inrush can take several seconds to begin to fall to full load current (f.l.c.).
For selectivity with circuit breakers this start-up characteristic must not 'trip' the circuit breaker (see fig. 9).

STAR-DELTA

Star-delta starting circuits exhibit lower starting currents than d.o.l., typically 3 - 4 x full load current. However, a transient peak is normally associated with the changeover from star to delta. Hence MEM recommends that the same selection tables are used for both d.o.l. and star-delta starting circuits. See Table 6.

FIGURE 9



Circuit breaker characteristic curve MDH310

Typical d.o.l. motor circuit characteristic 2.2kW 3ph.

TABLE 6

THREE PHASE MOTORS @ 415V

kW	F.L.C. (Ie)	MCB RATING TYPE C (A)	MCB RATING TYPE D (A)	MCCB RATING G FRAME (A)	MCCB RATING F FRAME (A) Std. Fixed Trip	MCCB RATING F FRAME (A) Adj. Trip	MCCB RATING J FRAME (A)	MCCB RATING K FRAME (A)	MCCB RATING L FRAME (A)	FUSELINKS D.O.L. STD FUSE (A)	MOTOR RATED FUSE
0.37	1.3	4	2							6	
0.56	1.6	4	2							6	
0.75	1.8	4	2							10	
1.1	2.6	6	4							10	
1.5	3.4	6	6							10	
2.2	5	10	10							16	
3	6.5	13	13							16	
3.7	8	16	13							20	
4	8	16	13	16	16					20	20M25
5.5	11	20	20	20	20					25	20M32
7.5	15	32	25	32	32					40	32M40
9.3	18	32	32	32	32					40	32M40
10	20	40	32	40	40					50	32M50
11	22	40	40	40	40					50	32M50
15	28	50	50	50	50	50				63	32M63
18.5	36	63	63	63	63	63				80	63M80
22	39	63	63	80	80	63				80	63M80
30	52			100	100	80				100	63M100
37	69			125	125	100				160	100M160
45	79				160	125				160	100M160
55	96				200	160				200	100M200
75	125						200			200	200M250
90	156						250			250	200M250
110	189						250	320		315	200M315
132	224							400		355	315M400
150	255							400		400	315M400
160	275							400	630	450	
185	318								800	500	
200	339								800	500	

SINGLE PHASE MOTORS @ 240V

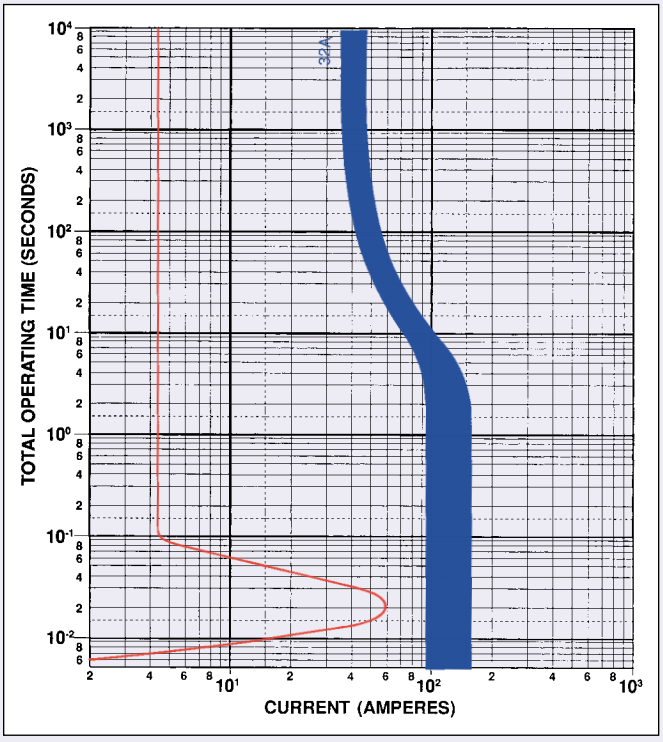
kW	F.L.C.	MCB RATING TYPE C (A)	MCB RATING TYPE D (A)	MCCB RATING G FRAME (A)	MCCB RATING F FRAME (A) Std. Fixed Trip	MCCB RATING F FRAME (A) Adj.* Trip	FUSELINKS D.O.L.
0.25	2.6	6	6				10
0.37	3.6	10	10				10
0.56	5	16	13				16
0.75	6.7	20	16	16	16		20
1.1	9	25	20	16	32		25
1.5	12	32	25	32	32		32
2.2	17	50	40	32	40		40
3	22	63	50	40	40		50
3.7	25	63	63	50	50	50	63
4	27	63	63	50	50	50	63
5.5	38	–	–	63	80	63	100
7.5	50	–	–	80	100	80	100

*Using 3 pole MCCB

CIRCUIT BREAKER SELECTION CHARTS FOR CONNECTION IN THE PRIMARY WINDINGS OF TRANSFORMERS.

Due to the inductive windings of transformers a high inrush current is experienced upon 'switch-on'. Typically this can be 10 - 15 x full load current of the transformer (In) and is virtually instantaneous. To protect supply lines to the primary windings of a transformer the circuit breaker must provide thermal (long time) protection and magnetic (short time) protection without the device tripping when the transformer is switched on (see fig. 10).

FIGURE 10



32A Type B MCB (MBH132).

Typical 1000VA transformer curve 1ph.

TABLE 7

SINGLE PHASE – 240V TRANSFORMERS ASSUMED TRANSFORMER INRUSH CHARACTERISTICS = 15 x In

Selection table for protection of primary transformer windings. For information on selection with lower/higher transformer VA, or lower/higher inrush characteristics please consult our Technical Services Department.

TRANSFORMER		CIRCUIT BREAKER TYPE					HRC FUSELINK
TRANSFORMER (VA) 240V	PRIMARY (A) 240V	MCB TYPE B (A)	MCB TYPE C (A)	MCB TYPE D (A)	MCCB G FRAME (A)	MCCB F FRAME (A)	STANDARD FUSE (A)
100	0.42	6	–	–	–	–	2
250	1.04	10	6	–	–	–	6
500	2.08	16	10	6	–	–	10
1000	4.17	32	16	10	–	–	16
1500	6.25	40	20	10	16	16	16
2000	8.33	50	32	16	16	16	20
2500	10.42	63	32	16	20	20	20
3000	12.50	–	40	20	32	32	25
3500	14.58	–	50	32	32	32	25
4000	16.67	–	63	32	32	32	32
4500	18.75	–	63	32	40	40	32
5000	20.83	–	–	32	40	40	40
7500	31.25	–	–	–	63	63	50
10000	41.67	–	–	–	80	80	63
12500	52.08	–	–	–	100	100	80
15000	62.50	–	–	–	125	125	100
20000	83.33	–	–	–	–	160	125

THREE PHASE – 415V TRANSFORMERS ASSUMED TRANSFORMER INRUSH CHARACTERISTICS = 15 x In

TRANSFORMER		CIRCUIT BREAKER TYPE					HRC FUSELINK
TRANSFORMER (VA) 415V	PRIMARY (A) 415V	MCB TYPE B (A)	MCB TYPE C (A)	MCB TYPE D (A)	MCCB G FRAME (A)	MCCB F FRAME (A)	STANDARD FUSE (A)
500	0.69	6	6	–	–	–	6
1000	1.39	10	6	6	–	–	10
1500	2.08	16	10	6	–	–	10
2000	2.78	16	10	6	–	–	10
2500	3.47	16	16	6	–	–	16
3000	4.17	20	16	10	–	–	16
3500	4.86	32	16	10	–	–	16
4000	5.56	32	20	10	16	16	16
4500	6.25	32	20	10	16	16	16
5000	6.94	40	32	16	16	16	20
7500	10.42	63	32	16	20	20	20
10000	13.89	–	50	25	32	32	32
12500	17.36	–	63	32	40	40	40
15000	20.83	–	63	32	40	40	40
20000	27.78	–	–	–	63	63	50
25000	34.72	–	–	–	80	80	63
30000	41.67	–	–	–	80	80	63
35000	48.61	–	–	–	100	100	80
40000	55.56	–	–	–	125	125	100
45000	62.50	–	–	–	125	125	100
50000	69.44	–	–	–	–	160	125
55000	76.39	–	–	–	–	160	125
60000	83.33	–	–	–	–	160	125
65000	90.28	–	–	–	–	200	160
70000	97.22	–	–	–	–	200	160
75000	104.17	–	–	–	–	200	160

N.B. All MCCB thermal and magnetic adjustments are assumed to be set at maximum where applicable. For fuselinks, some degree of overloading allowed. For specific examples contact our Technical Services Department.

MEMSHIELD 2

Selection Criteria

WHAT DO THE ABBREVIATIONS MEAN?

R.C.D.: Residual Current Device is the generic term covering the range of devices incorporating sensing of residual current and includes within the scope R.C.C.B. and R.C.B.O. type products.

R.C.C.B.: Residual Current Circuit Breaker is an RCD which will cause disconnection of electrical supply should a residual current passing through the device exceed a specified level.

R.C.B.O.: Residual Current Circuit Breaker with Overload protection is an RCD which will cause disconnection of electrical supply due to residual current exceeding specified limits together with integral overload; overcurrent and short circuit protection associated with a miniature circuit breaker.

DEFINITIONS:

Residual Current: is the vector sum of the currents of all the phases and associated neutral passing through the core balance transformer of an RCD.
Equipotential Zone: the zone within which all conductive parts are maintained at substantially the same potential by bonding to Earth.

WHEN MUST AN RCD BE USED?

		BS7671 (16th Edition IEE Regs)
i)	Sockets outlets on a TT supply	(471-08-06)
ii)	Sockets to supply portable equipment outside the equipotential zone	(471-16-01)
iii)	Supply to caravan	(608-13-05)

WHEN IS IT ADVISABLE TO INSTALL AN RCD?

- For protection against risk of fire due to live to earth fault where fault current is insufficient to cause over-current protection device to operate.
- For protection against risk of shock from indirect contact with equipment suffering a live to earth fault.
- For protection against shock in potentially hazardous environment.
- As supplementary protection against shock from directly touching 'Live' parts.

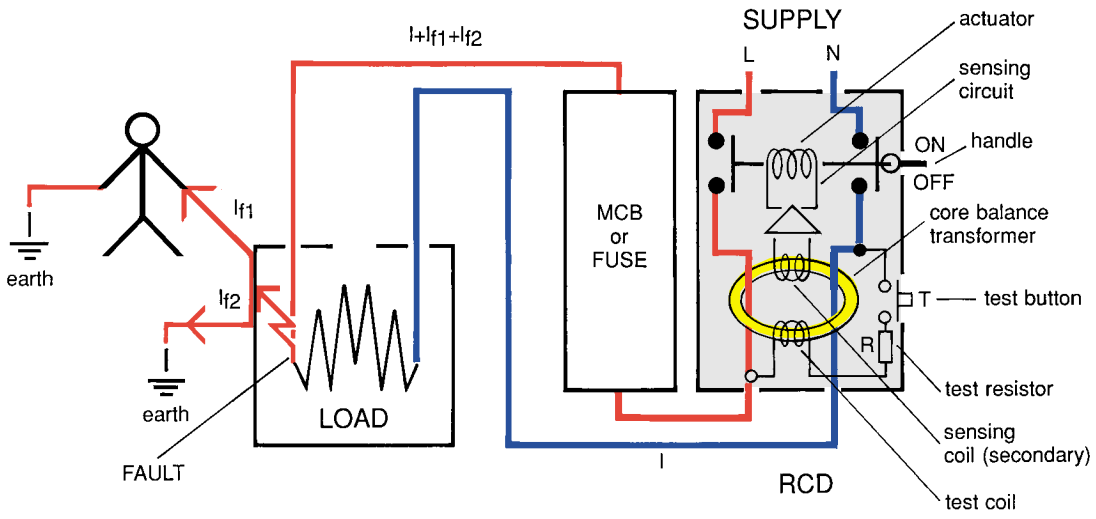
Note: an RCD must not be used as the sole means of protection against touching live parts.

WHAT TRIP CURRENT RATING SHOULD BE SELECTED?

10mA – to give a high degree of protection against electric shock in a hazardous environment situation where supplementary protection against shock from accidental direct contact is required.
This rating should only be used to supply final circuits where a high risk exists.
30mA – to give a high degree of protection against electric shock in a situation where supplementary protection against shock from accidental direct contact is required when it must be able to trip within 40 milliseconds when a fault current of 150mA is detected. This will also satisfy the IEE/BS condition for supplementary protection of sockets feeding portable equipment outside the equipotential zone.
100mA – to give a degree of protection against electric shock due to indirect contact situation.
Generally this rating should be used to protect groups of circuits and provide overall protection against fire risk.
If lower rated RCD devices are employed down stream then a time delayed 100mA RCD should be employed to ensure discrimination between same.
300mA – gives overall protection against risk of fire from electrical faults in wiring etc, only where sufficient current (typically less than 500mA) may cause incandescence of metal parts in suitable circumstances and in consideration that installed over current devices would require far in excess of 300mA to operate.
If lower rated RCD devices are employed down stream then a time delayed 300mA RCD should be employed to ensure discrimination between same.
NOTE: 10mA; 30mA and 100mA also inherently protect against this risk.

RCD Technical Information and Operating Principles

PRINCIPLES OF OPERATION OF RCCB



Schematic diagram of RCD connected to earth fault showing principle parts of installation

BRIEF EXPLANATION OF OPERATING FUNDAMENTALS

When a Load is connected to the circuit supplied through an **RCD** current flows from the **SUPPLY** through the **RCD** whereby both phase and neutral form the primaries of a **CORE BALANCE TRANSFORMER** arrangement, the **SECONDARY** of which is used as a **SENSING COIL** to detect any out of balance between the current flowing through the live and neutral conductors in the circuit.

A test circuit is also incorporated whereby connection is made from load phase to supply neutral via a **TEST COIL** and **RESISTOR** and activated by a **TEST BUTTON.**

This test circuit is designed to pass a current well in excess of the related tripping current of the **RCD** in question.

If a fault occurs on the load side of the **RCD** whereby a fault current (Ifn) flows between Live and Earth. The Load still demands a current return through the neutral of the RCD of I amps whilst the current flow through the Live becomes I + Ifn and from this imbalance a corresponding current will be induced electro-magnetically in the sensing coil which if of sufficient magnitude and duration will cause the actuator to function and trip the RCD thereby disconnecting the supply.

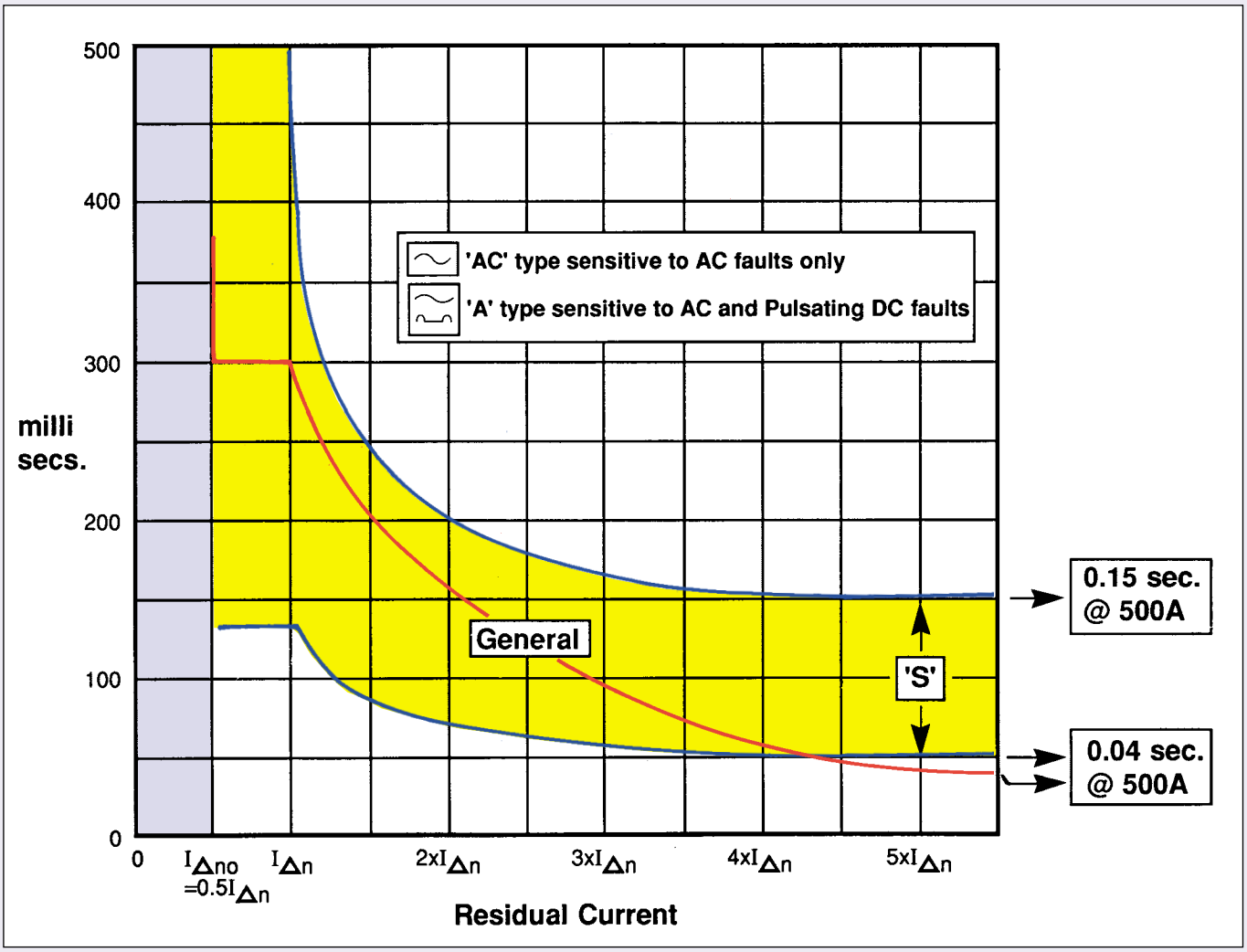
However it should be noted that other disturbances that may cause imbalance between phase and neutral can emanate from upstream and/or downstream sources to give rise to the effect of unwanted tripping as identified in **'Trouble-shooting'**on page 30.

MEMSHIELD 2 RCD Technical Information

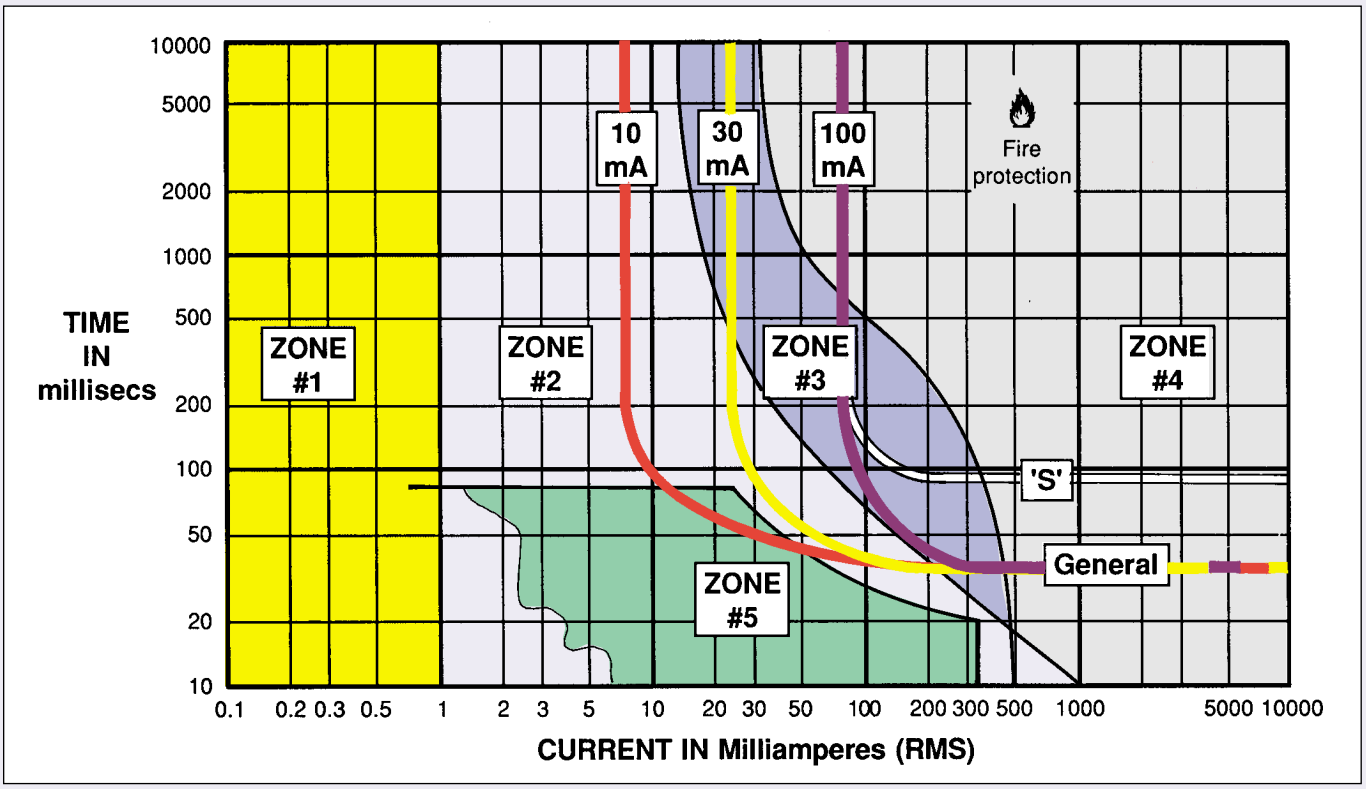
Operating Characteristics

TYPE	RATED CURRENT I_n	TRIPPING CURRENT $I_{\Delta n}$	STANDARD AND TYPICAL VALUES OF BREAK TIME AND NON ACTUATING TIME (SECS) AT RESIDUAL CURRENT ($I_{\Delta n}$) EQUAL TO:				
			STANDARD $I_{\Delta n}$	TYPICAL $I_{\Delta n}$	STANDARD $5 \times I_{\Delta n}$	TYPICAL $5 \times I_{\Delta n}$	
General'	any value	any value	0.3 sec	0.1 sec	0.04 sec	0.035 sec	Maximum break time
'S' (time delay)	≥25A	>30mA	0.5 sec	0.3 sec	0.15 sec	0.08 sec	Maximum break time
			0.13 sec	0.3 sec	0.05 sec	0.08 sec	Min. non-actuating time

NOTE: For RCCBs of the general type integrated in one unit with a socket outlet or designed exclusively for being associated locally with a socket outlet in the same mounting box and for RCCBs with $I_{\Delta n} \leq 0.030A$, 0.25A may be used as an alternative to $5I_{\Delta n}$.



SHOCK HAZARD CURVES BASED ON IEC PUBLICATION 479 WITH MEM RCD PRODUCT TRIPPING CURVES SUPERIMPOSED.



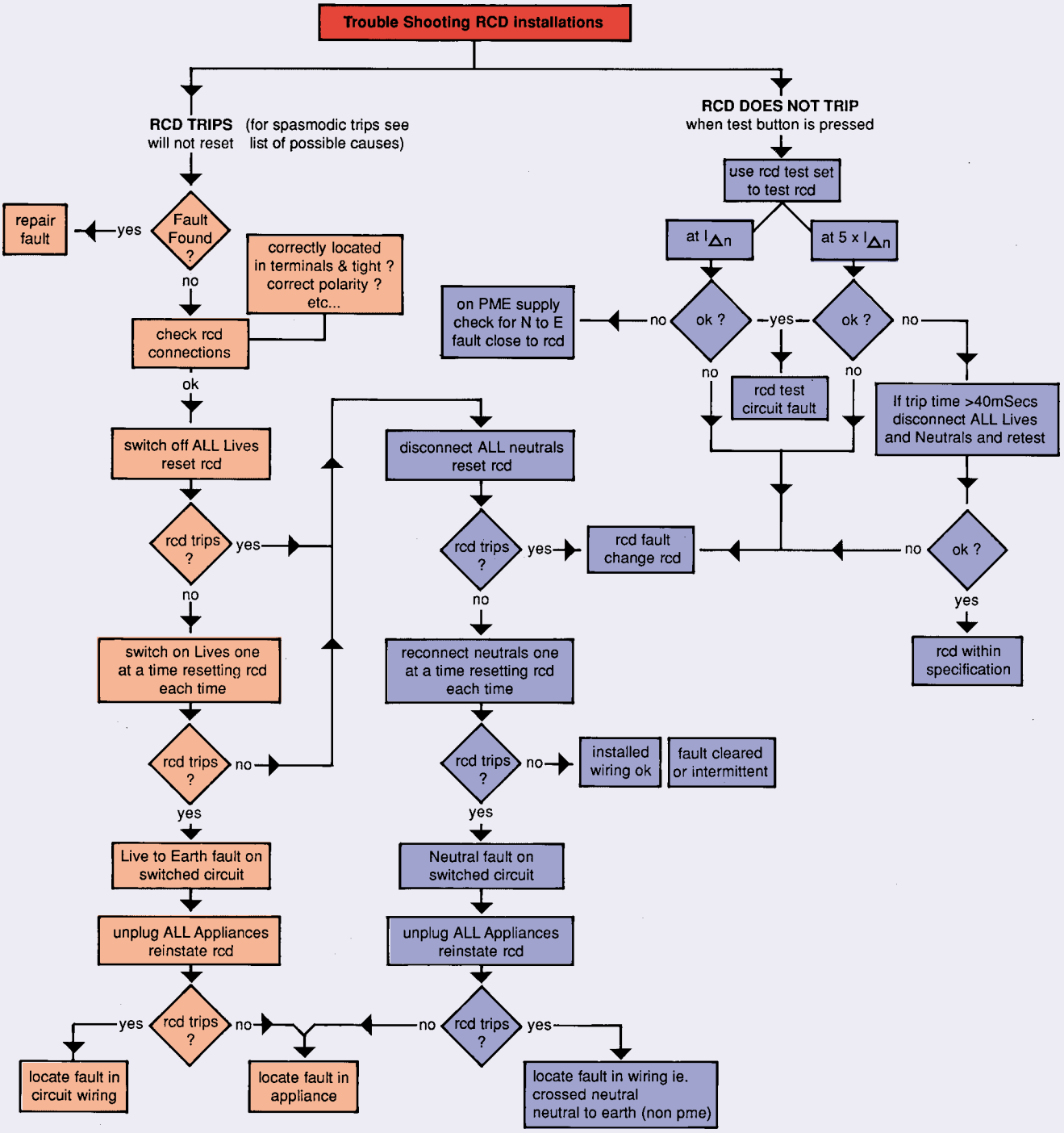
ZONE No. 1 Usually no adverse reaction.

ZONE No. 2 Usually no harmful physiological effects, reaction current >0.5mA, 'let-go' current about 10.5mA.

ZONE NO. 3 No organic damage. Likelihood of muscular contraction and difficulty of breathing, reversible disturbances of impulses in the heart, transient cardiac arrest without ventricular fibrillation increases with current magnitude and time.

ZONE No. 4 In addition to effects of zone No. 3 probability of ventricular fibrillation increasing with current magnitude and time, pathyphysiological effects such as cardiac arrest, breathing arrest and heavy burns likely. Risk of fire emanating from faulty electrical equipment producing current less than that able to operate MCB or fuse increases with increasing current (long term deterioration).

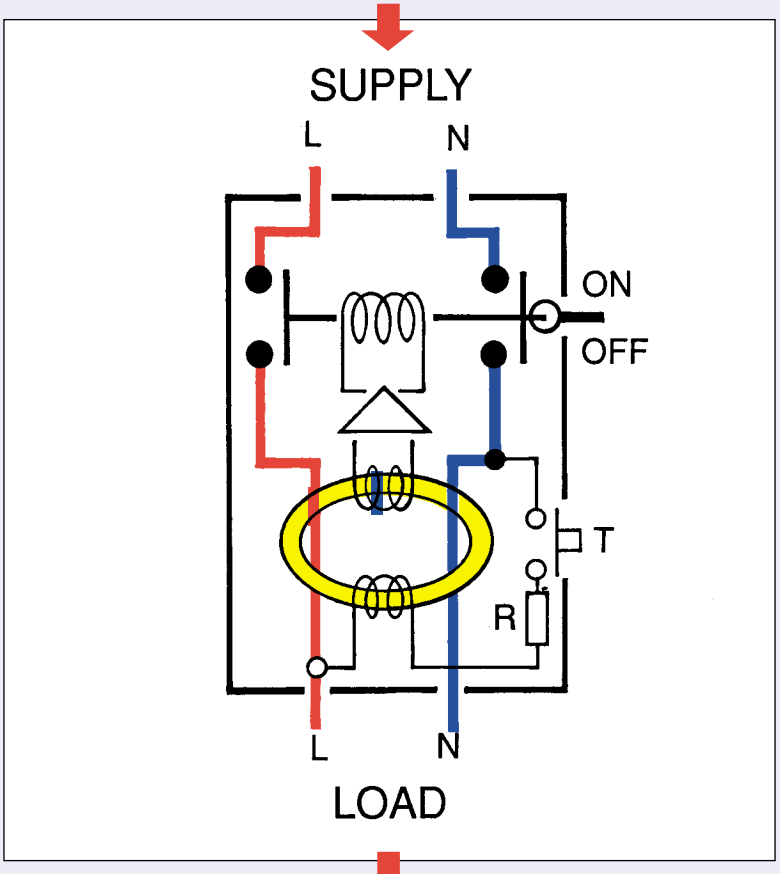
ZONE No. 5 Area relating to residual current and time where most disturbances emanating from appliances and installed services may be found (from results of mains monitoring and recording).



WARNING: DUE TO THE REQUIREMENTS OF WORKING IN CLOSE PROXIMITY TO LIVE PARTS THESE PROCEDURES SHOULD ONLY BE CARRIED OUT BY PERSONS WHO MAY BE CONSIDERED TO BE COMPETENT 'ELECTRICIANS'

LIST OF POSSIBLE CAUSES WHICH MAY BE RESPONSIBLE FOR SPASMODIC RCD TRIPPING.

INCOMING
(non-protected 'upstream' of RCD)
Loose connections
Mains borne disturbance (effect worse off load) exceeding EMC Std.EN50082-1
Site machinery/plant
Installed services
Lightning strike
etc . . .



OUTGOING
Protected 'down stream' side)
Mains borne (effect worse off load) (exceeding EMC Std. EN50082-1)

Wrongly Specified	Loose connections
Incorrect application	Wet plaster
No discrimination between RCDs	Condensation (ie behind appliances)
Crossed Neutral on split load	Mineral insulated conductors
N to E fault on non PME (trips)	Heating elements (new or old)
N to E fault on PME (no trip)	Householder faults (picture hooks etc)
High standing earth leakage	Moisture ingress (appliance sockets etc)
Appliances and installed services	etc.

MEMSHIELD 2 Modular Contactors

Technical Information

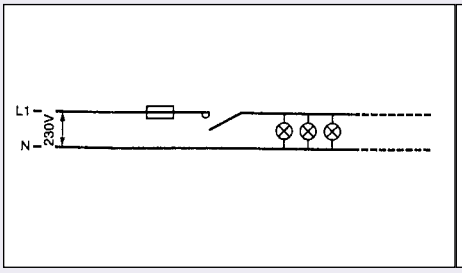
TYPE			AA16	AA20	AA40	AA63	
ENVIRONMENT							
Rated insulation voltage (Ui)	Conforming to IEC 1095 Conforming to VDE 0110	V	500				
Rated impulse withstand voltage (Uimp)		kV	4 in enclosure				
Conforming to standards			IEC 61095, VDE 0660 and BSEN 60947-5 for auxillary contacts				
Approvals			NF- USE, VDE, CEBEC, ÖVE				
Degree of protection	Conforming to VDE 0106		Protection against direct finger contact (IP 20 open, IP 40 in enclosure)				
Protective treatment	Standard version		"TC"				
Ambient air temperature around the device	Storage version Operation	°C °C	- 40... +70 - 5... + 50 (0.85...1.1 Uc)				
Maximum operating altitude	Without derating	m	3000				
Operating positions	Without derating		± 30° in relation to normal vertical mounting position				
Shock resistance ½ sine wave = 10ms	Contactor open Contactor closed		10gn 15gn				
Vibration resistance 5...300Hz	Contactor open Contactor closed		2gn 3gn				
Flame resistance			Conforming to IEC 61095				
Opacity and toxicity of fumes			Conforming to NF F 16-101 and 16-102				
POLE CHARACTERISTICS Number of poles			2, 3 or 4				
Rated operational current (Ie) (Ue ≤ 440 V)	In AC - 7a (heating) In AC - 7b (motor control)	A A	16 5	25 8.5	40 15	63 25	
Rated operational voltage (Ue)	Up to	V	250 two-pole contactors, 415 three and four-pole contactors				
Frequency limits	Of the operational current	Hz	400				
Conventional thermal current (Ith)	ø ≤ 50 °C	A	16	25	40	63	
Rated making and breaking capacity	Conforming to IEC 1095 (AC-7b) I rms 400 V 3-phase	A	40	68	120	200	
Permissible short time rating with no current flow for the previous 15 minutes and with ø ≤ 40 °C	For 10s For 30s	A A	128 40	200 62	320 100	504 157	
Short-circuit protection by fuse or circuit breaker U ≤ 440 V	gl fuse Circuit breaker I^2t 230V (at 3 kA rms prospective) 400V	A A^2s A^2s	16 5000 9000	25 10000 14000	40 16000 17500	63 18000 20000	
Average impedance per pole	At Ith and 50Hz	mΩ	2.5	2.5	2	2	
Power dissipated per pole	For the above operational currents	W	0.65	1.6	3.2	8	
Maximum cabling c.s.a Flexible cable without cable end	1 conductor 2 conductors	mm^2 mm^2	6 4	6 4	25 16	25 16	
Flexible cable with cable end	1 conductor 2 conductors	mm^2 mm^2	6 1.5	6 1.5	16 4	16 4	
Solid cable without cable end	1 conductor 2 conductors	mm^2 mm^2	6 4	6 4	25 6	25 6	
Tightening torque	Power circuit connections	N.m	1.4	1.4	3.5	3.5	

TYPE CONTROL CIRCUIT CHARACTERISTICS			AA16 AA20 SINGLE OR 2-POLE	AA16 AA20 3 OR 4-POLE AA40 AA63 2-POLE	AA40 AA63 3 OR 4-POLE
Rated control circuit voltage (Uc)	50 or 60 Hz	V	12...240V, for other voltages, please consult us		
Control voltage limits (ø ≤ 50˚ C) 50 Hz coils	Operational		0.85...1.1Uc		
	Drop out		0.2...0.75Uc		
Average coil consumption at 20˚ C and at Uc ~ 50 Hz	Inrush	VA	15	34	53
	Sealed	VA	3.8	4.6	6.5
Maximum heat dissipation	50/60 Hz	W	1.3	1.6	2.1
Operating times (1)	Closing “C” Opening “O”	ms ms	10...30 10...25		
Mechanical durability	In operating cycles		10^6		
Maximum operating rate at ambient temperature ≤ 50˚ C	In operating cycles per hour		300		
Maximum cabling c.s.a					
Flexible cable without cable end	1 or 2 conductors	mm^2	2.5		
Flexible cable with cable end	1 conductor	mm^2	2.5		
	2 conductors	mm^2	1.5		
Solid cable without cable end	1 or 2 conductors	mm^2	1.5		
Tightening torque		N.m	1.4		
INSTANTANEOUS AUXILIARY CONTACT CHARACTERISTICS					
Rated operational voltage (Ue)	Up to	V	250		
Rated insulation voltage (Ui)	Conforming to BSEN 60947-5	V	500		
	Conforming to VDE 0110	V	500		
Conventional thermal current (Ith)	For ambient ø ≤ 50 ˚C	A	5		
Mechanical durability	Operating cycles		10^6		
Maximum cabling c.s.a.	Flexible or solid conductor	mm^2	2.5		
Tightening torque		N.m	1.4		

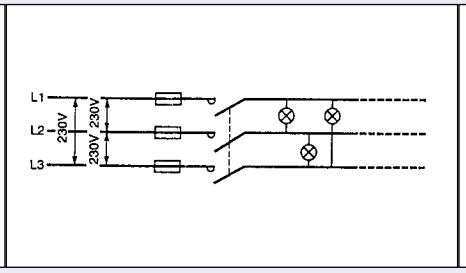
LIGHTING (MAXIMUM NUMBER OF LAMPS DEPENDING ON THE POWER OF EACH UNIT)

Presentation of installations according to type of supply:

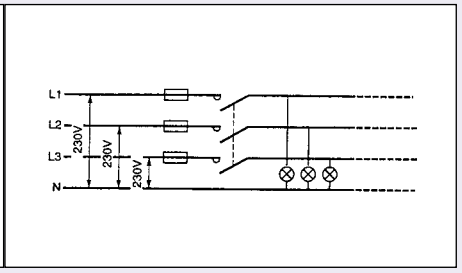
Single phase circuit, 230 V



3-phase circuit, 230 V



3-phase circuit, 400V (with neutral)



The maximum number of lamps which can be operated per phase is equal to the total number of lamps in the "single-phase 230 V" table divided by $\sqrt{3}$.

The maximum number of lamps which can be operated per phase is equal to the total number of lamps in the "single-phase 230V" table.

LIGHTING (MAXIMUM NUMBER OF LAMPS DEPENDING ON THE POWER OF EACH UNIT) CONTINUED

Contactor rating indicated below for a single-phase 230 V circuit (single-pole)

FLUORESCENT LAMPS WITH STARTER

Single fitting	Non corrected					With parallel correction					Contactor rating
P in W	20	40	50	80	110	20	40	58	80	110	-
I in A	0.39	0.43	0.70	0.80	1.2	0.19	0.29	0.46	0.57	0.79	-
C in µF	-	-	-	-	-	5	5	7	7	16	-
Maximum	22	20	13	10	7	15	15	10	10	5	16 A
number	30	28	17	15	10	20	20	15	15	7	25 A
of lamps	70	60	35	30	20	40	40	30	30	14	40 A
	100	90	56	48	32	60	60	43	43	20	63 A
Twin fitting	Non corrected					With series correction					Contactor rating
P in W	2x18	2x36	2x58	2x80	2x140	2x18	2x36	2x58	2x80	2x140	-
I in A	0.44	0.82	1.34	1.64	2.2	0.26	0.48	0.78	0.96	1.3	-
C in µF	-	-	-	-	-	3.5	4.5	7	9	18	-
Maximum	20	11	7	5	4	30	17	10	9	6	16 A
number	30	16	10	8	6	46	25	16	13	10	25 A
of lamps	50	26	16	13	10	80	43	27	22	16	40 A
	75	42	25	21	16	123	67	42	34	25	63 A

HIGH PRESSURE MERCURY VAPOUR LAMPS

	Non corrected						With parallel correction							Contactor rating
P in W	50	80	125	250	400	700	50	80	125	250	400	700	1000	-
I_B in A	0.6	0.8	1.15	2.15	3.25	5.4	0.35	0.50	0.7	1.5	2.4	4	5.7	-
C in µF	-	-	-	-	-	-	7	8	10	18	25	40	60	-
Maximum	15	10	8	4	2	1	10	9	9	4	3	2	-	16 A
number	20	15	10	6	4	2	15	13	10	6	4	2	1	25 A
of lamps	34	27	20	10	6	4	28	25	20	11	8	5	3	40 A
	53	40	28	15	10	6	43	38	30	17	12	7	5	63 A

LOW PRESSURE SODIUM VAPOUR LAMPS

	Non corrected						With parallel correction						Contactor rating
P in W	18	35	55	90	135	180	18	35	55	90	135	180	-
I_B in A	0.35	1.4	1.4	2.1	3.1	3.1	0.35	0.6	0.6	0.9	0.9	0.9	-
C in µF	-	-	-	-	-	-	5	20	20	26	45	40	-
Maximum	18	4	5	3	2	2	14	3	3	2	1	1	16 A
number	34	9	9	6	4	4	21	5	5	4	2	2	25 A
of lamps	57	14	14	9	6	6	40	10	10	8	4	5	40 A
	91	24	24	19	10	10	60	15	15	11	6	7	63 A

HIGH PRESSURE SODIUM VAPOUR LAMPS

	Non corrected					With parallel correction					Contactor rating
P in W	70	150	250	400	1000	70	150	250	400	1000	-
I_B in A	1	1.8	3	4.4	10.3	0.6	0.7	1.5	2.5	6	-
C in µF	-	-	-	-	-	12	12	32	25	45	-
Maximum	8	4	2	1	-	6	6	2	2	1	16 A
number	12	7	4	3	1	9	9	3	4	2	25 A
of lamps	20	13	8	5	2	18	18	6	8	4	40 A
	32	18	11	8	3	25	25	9	12	6	63 A

METAL IODINE OR HALOGEN VAPOUR LAMPS

	Non corrected						With parallel correction							Contactor rating
P in W	35	70	150	250	400	1000	39	70	150	250	400	1000	2000	-
I_B in A	0.3	0.5	1	1.5	2.5	6	0.3	0.5	1	1.5	2.5	6	5.5	-
C in µF	-	-	-	-	-	-	6	12	20	32	45	85	60	-
Maximum	27	16	8	5	3	1	12	6	4	3	2	-	1	16 A
number	40	24	12	8	5	2	18	9	6	4	3	1	2	25 A
of lamps	68	42	20	14	8	4	31	16	10	7	5	3	3	40 A
	106	64	32	21	13	5	50	25	15	10	7	4	5	63 A

INCANDESCENT AND HALOGEN LAMPS

P in W	60	75	100	150	200	300	500	1000	-
I_B in A	0.26	0.32	0.44	0.65	0.87	1.30	2.17	4.4	-
Maximum	30	25	19	12	10	7	4	2	16 A
number	45	38	28	18	14	10	6	3	25 A
of lamps	85	70	50	35	26	18	10	6	40 A
	125	100	73	50	37	25	15	8	63 A

I_B : value of current drawn by each lamp at its rated operational voltage.
C : unit capacitance for each lamp.
I_B and C correspond to values normally quoted by lamp manufacturers

LIGHTING (MAXIMUM NUMBER OF LAMPS DEPENDING ON THE POWER OF EACH UNIT) CONTINUED

Contactor rating indicated below for a single-phase 230 V circuit (single-pole)

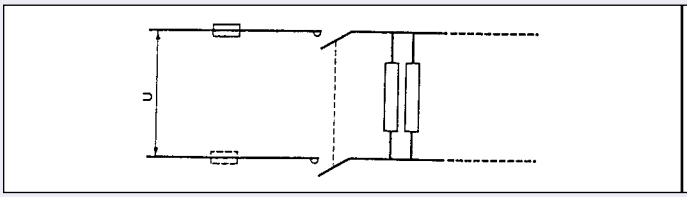
HALOGEN LAMPS USED WITH TRANSFORMER

					Contactor rating
P in W	60	80	105	150	-
IB in A	0.26	0.35	0.45	0.65	-
Maximum number of lamps	9	8	6	4	16 A
	14	12	9	6	25 A
	27	23	18	13	40 A
	40	35	27	19	63 A

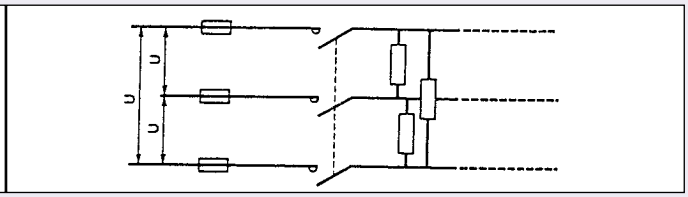
IB : value of current drawn by each lamp at its rated operational voltage.
C : unit capacitance for each lamp.
IB and C correspond to values normally quoted by lamp manufactures

HEATING (AC-7a)

Single-phase, 2-pole switching



3-phase switching



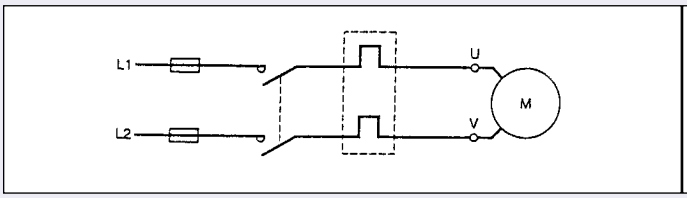
Heating by resistive elements or by infra-red radiators, convectors or radiators, heating ducts, industrial furnaces. The current peak between the hot and cold states must not exceed 2 to 3 in at the moment of switch-on.

MAXIMUM POWER In kW (ACCORDING TO ELECTRICAL DURABILITY)

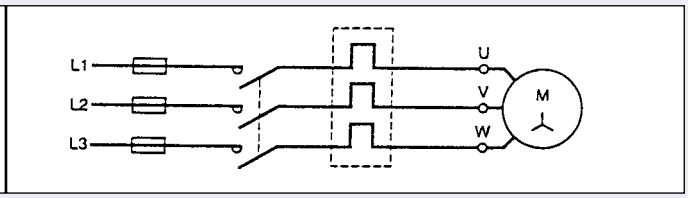
Electrical durability in operating cycles	100 x 10^3	150 x 10^3	200 x 10^3	500 x 10^3	10^6	Contactor rating
Single-phase switching 230 V (2 pole)	3.5	3	2.2	1	0.8	16 A
	5.4	4.6	3.5	1.6	1.2	25 A
	8.6	7.4	5.6	2.6	1.9	40 A
	13.6	11.6	8.8	4	3	63 A
3-phase switching 400 V (3 pole)	10	9	6.5	3.2	2.2	16 A
	16	14	10	5	3.5	25 A
	26	22	17	7.5	6	40 A
	41	35	26.5	12	9	63 A

MOTOR CONTROL (AC-7b)

Single-phase circuit, 230 V



3-phase circuit, 400 V



MAXIMUM POWER In kW

230 V single-phase Capacitor motor (2-pole)	400 V 3-phase motor	Contactor rating (Ith)
0.55	2.2	16 A
1.1	4	25 A
2.2	7.5	40 A
4	11	63 A

MEMSHIELD 2 TYPE B

TYPE OF DEVICE = MINIATURE CIRCUIT BREAKER (MCB)
RATED VOLTAGE = 415 Volts AC
FREQUENCY = 50/60 Hertz
SHORT CIRCUIT CATEGORY = 10kA (415 Volts) 1 TO 63 Amps

MAXIMUM EARTH LOOP IMPEDANCE Zs (OHMS):

In (A)	SOCKET OUTLET CIRCUITS (0.4 secs)	FIXED APPLIANCE CIRCUITS (5 secs)
1	48.0	49.0
2	24.0	24.0
4	12.00	12.00
6	8.00	8.28
8	6.00	7.50
10	4.80	6.00
13	3.69	4.70
16	3.00	3.69
20	2.40	3.00
25	1.92	2.28
32	1.50	1.71
40	1.20	1.5
50	0.96	1.17
63	0.76	1.04

DISCONNECTION TIME/CURRENT DATA:

DISCONNECTION TIME (s)	60.00	10.00	5.00	1.00	0.40	0.10
In (A)	DISCONNECTION CURRENT (A)					
1	2.10	4.20	4.90	5.00	5.00	5.00
2	4.20	9.00	10.00	10.00	10.00	10.00
4	8.00	16.00	20.00	20.00	20.00	20.00
6	13.00	17.5	29.00	30.00	30.00	30.00
8	16.00	25.00	32.00	40.00	40.00	40.00
10	20.00	30.00	40.00	50.00	50.00	50.00
13	22.00	40.00	51.00	65.00	65.00	65.00
16	31.00	50.00	65.00	80.00	80.00	80.00
20	39.00	64.00	80.00	100.00	100.00	100.00
25	50.00	80.00	105.00	125.00	125.00	125.00
32	62.00	105.00	140.00	160.00	160.00	160.00
40	80.00	145.00	160.00	200.00	200.00	200.00
50	100.00	160.00	205.00	250.00	250.00	250.00
63	120.00	190.00	230.00	315.00	315.00	315.00

MAXIMUM LET THROUGH ENERGY:

PROSPECTIVE SHORT CIRCUIT (kA)	0.5	1	2	3	5	10
In (A)	I^2t (A^2 sec)					
1	140	200	240	270	300	370
2	650	1050	2000	2900	4700	8000
4	880	1550	3000	4200	7000	12500
6	1020	1750	3400	5100	8100	15000
8	1250	2100	4000	5900	9500	18000
10	1350	2500	4750	7000	11500	21000
13	1500	2700	5200	7700	13000	24000
16	1600	3000	5800	8700	14500	27000
20	1800	3500	7000	10500	18000	33000
25	2000	3600	7700	12000	20000	38000
32	2100	4000	8300	13000	22000	43000
40	2400	4300	9300	14000	26000	51000
50	2600	5100	11000	17000	31000	61000
63	-	6000	13000	21000	38000	80000

Circuit Breaker Data

MEMSHIELD 2 TYPE C

TYPE OF DEVICE = MINIATURE CIRCUIT BREAKER (MCB)
RATED VOLTAGE = 415 Volts AC
FREQUENCY = 50/60 Hertz
SHORT CIRCUIT CATEGORY = 10kA (415 Volts) 1 TO 63 Amps

MAXIMUM EARTH LOOP IMPEDANCE Zs (OHMS):

In (A)	SOCKET OUTLET CIRCUITS (0.4 secs)	FIXED APPLIANCE CIRCUITS (5 secs)
1	24.00	34.29
2	12.00	17.78
4	6.00	9.20
6	4.00	6.00
8	3.00	7.05
10	2.40	5.71
13	1.85	4.36
16	1.50	3.42
20	1.20	2.67
25	0.96	2.18
32	0.75	1.60
40	0.60	1.20
50	0.48	1.09
63	0.38	0.90

DISCONNECTION TIME/CURRENT DATA:

DISCONNECTION TIME (s)	60.00	10.00	5.00	1.00	0.40	0.10
In (A)	DISCONNECTION CURRENT (A)					
1	2.20	5.00	7.00	10.00	10.00	10.00
2	4.20	9.50	13.50	20.00	20.00	20.00
4	8.00	19.00	26.00	40.00	40.00	40.00
6	12.00	24.00	40.00	60.00	60.00	60.00
8	16.00	26.00	34.00	80.00	80.00	80.00
10	20.00	32.00	42.00	90.00	100.00	100.00
13	26.00	41.00	55.00	110.00	130.00	130.00
16	31.00	50.00	70.00	150.00	160.00	160.00
20	40.00	68.00	90.00	180.00	200.00	200.00
25	50.00	80.00	110.00	210.00	250.00	250.00
32	65.00	110.00	150.00	290.00	320.00	320.00
40	81.00	140.00	200.00	350.00	400.00	400.00
50	100.00	175.00	220.00	450.00	500.00	500.00
63	130.00	205.00	270.00	550.00	630.00	630.00

MAXIMUM LET THROUGH ENERGY:

PROSPECTIVE SHORT CIRCUIT (kA)	0.5	1	2	3	5	10
In (A)	I^2t (A^2 sec)					
1	140	200	240	270	300	370
2	650	1050	2000	2900	4700	8000
4	880	1550	3000	4200	7000	12500
6	1020	1750	3400	5100	8100	15000
8	1250	2100	4000	5900	9500	18000
10	1350	2500	4750	7000	11500	21000
13	1500	2700	5200	7700	13000	24000
16	1600	3000	5800	8700	14500	27000
20	1800	3500	7000	10500	18000	33000
25	2000	3600	7700	12000	20000	38000
32	2100	4000	8300	13000	22000	43000
40	2400	4300	9300	14000	26000	51000
50	2600	5100	11000	17000	31000	61000
63	-	6000	13000	21000	38000	80000

MEMSHIELD 2 TYPE D

TYPE OF DEVICE = MINIATURE CIRCUIT BREAKER (MCB)
RATED VOLTAGE = 415 Volts AC
FREQUENCY = 50/60 Hertz
SHORT CIRCUIT CATEGORY = 10kA (415 Volts) 1 TO 63 Amps
6kA 40A, 50A & 63A

MAXIMUM EARTH LOOP IMPEDANCE Zs (OHMS):

In (A)	SOCKET OUTLET CIRCUITS (0.4 secs)	FIXED APPLIANCE CIRCUITS (5 secs)
1	12.00	34.28
2	6.00	17.78
4	3.00	9.23
6	2.00	6.00
8	1.50	7.50
10	1.20	6.00
13	0.92	4.44
16	0.75	3.58
20	0.60	2.67
25	0.48	2.40
32	0.38	1.60
40	0.30	1.37
50	0.24	1.20
63	0.19	0.96

DISCONNECTION TIME/CURRENT DATA:

DISCONNECTION TIME (s)	60.00	10.00	5.00	1.00	0.40	0.10
In (A)	DISCONNECTION CURRENT (A)					
1	2.20	4.50	7.00	16.00	20.00	20.00
2	4.10	9.00	13.50	30.00	40.00	40.00
4	8.00	17.00	26.00	62.00	80.00	80.00
6	12.00	30.00	40.00	90.00	120.00	120.00
8	16.00	25.00	32.00	70.00	160.00	160.00
10	20.00	31.00	40.00	90.00	200.00	200.00
13	25.00	41.00	54.00	120.00	260.00	260.00
16	31.00	50.00	67.00	150.00	320.00	320.00
20	38.00	65.00	90.00	190.00	400.00	400.00
25	50.00	85.00	100.00	230.00	500.00	500.00
32	62.00	110.00	150.00	305.00	640.00	640.00
40	80.00	130.00	175.00	400.00	800.00	800.00
50	100.00	160.00	200.00	500.00	1000.00	1000.00
63	120.00	190.00	250.00	580.00	1260.00	1260.00

MAXIMUM LET THROUGH ENERGY:

PROSPECTIVE SHORT CIRCUIT (kA)	0.5	1	2	3	5	10
In (A)	I^2t (A^2 sec)					
1	140	200	240	270	300	370
2	650	1050	2000	2900	4700	8000
4	880	1550	3000	4200	7000	12500
6	1020	1750	3400	5100	8100	15000
8	1250	2100	4000	5900	9500	18000
10	1350	2500	4750	7000	11500	21000
13	1500	2700	5200	7700	13000	24000
16	1600	3000	5800	8700	14500	27000
20	1800	3500	7000	10500	18000	33000
25	2000	3600	7700	12000	20000	38000
32	2100	4000	8300	13000	22000	43000
40	2400	4300	9300	14000	26000	51000
50	2600	5100	11000	17000	31000	61000
63	-	6000	13000	21000	38000	80000

MEMSHIELD 2 G FRAME

TYPE OF DEVICE = MOULDED CASE CIRCUIT BREAKER (MCCB)
INSULATION VOLTAGE = 500 Volts AC
FREQUENCY = 50/60 Hertz
SHORT CIRCUIT CATEGORY = Icu 16/25kA (415 Volts)

MAXIMUM EARTH LOOP IMPEDANCE Zs (OHMS):

In (A)	SOCKET OUTLET CIRCUITS (0.4 secs)	FIXED APPLIANCE CIRCUITS (5 secs)
16	0.500	1.714
20	0.500	2.000
32	0.500	0.889
40	0.267	0.267
50	0.267	0.267
63	0.267	0.267
80	0.160	0.282
100	0.160	0.200
125	0.160	0.1714

DISCONNECTION TIME/CURRENT DATA:

DISCONNECTION TIME (s)	60.00	10.00	5.00	1.00	0.40	0.10
In (A)			DISCONNECTION CURRENT (A)			
16	38.00	80.00	140.00	480.00	480.00	480.00
20	47.00	90.00	120.00	370.00	480.00	480.00
32	85.00	175.00	270.00	480.00	480.00	480.00
40	140.00	470.00	900.00	900.00	900.00	900.00
50	160.00	500.00	900.00	900.00	900.00	900.00
63	205.00	500.00	900.00	900.00	900.00	900.00
80	270.00	600.00	850.00	1500.00	1500.00	1500.00
100	290.00	720.00	1200.00	1500.00	1500.00	1500.00
125	405.00	900.00	1400.00	1500.00	1500.00	1500.00

MCCB LET-THROUGH ENERGY DATA I^2t (A^2sec) G-FRAME

FAULT LEVEL (A)	RATING								
	16A	20A	32A	40A	50A	63A	80A	100A	125A
25000	360,000	360,000	500,000	525,000	630,000	630,000	660,000	660,000	660,000
16000	300,000	300,000	400,000	480,000	530,000	530,000	580,000	580,000	580,000
5000	220,000	220,000	295,000	320,000	360,000	360,000	400,000	400,000	400,000
3000	125,000	125,000	150,000	160,000	180,000	180,000	220,000	220,000	220,000
2000	35,000	35,000	36,000	36,500	40,000	40,000	47,000	47,000	47,000
1500	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000

MEMSHIELD 2 F FRAME

TYPE OF DEVICE = MOULDED CASE CIRCUIT BREAKER (MCCB)
INSULATION VOLTAGE = 690 Volts AC
FREQUENCY = 50/60 Hertz
SHORT CIRCUIT CATEGORY = Icu 25/45/65kA (415 Volts)

MAXIMUM EARTH LOOP IMPEDANCE Zs (OHMS):

In (A)	SOCKET OUTLET CIRCUITS (0.4 secs)			FIXED APPLIANCE CIRCUITS (5 secs)		
	Standard	Adjustable S/C set to min	Adjustable S/C set to max	Standard	Adjustable S/C set to min	Adjustable S/C set to max
16	1.500	-	-	2.000	-	-
20	1.200	-	-	1.600	-	-
32	0.75	-	-	0.960	-	-
40	0.600	-	-	0.730	-	-
50	0.480	0.800	0.400	0.550	0.800	0.400
63	0.380	0.640	0.317	0.400	0.640	0.317
80	0.300	0.500	0.250	0.300	0.500	0.250
100	0.240	0.400	0.200	0.240	0.400	0.200
125	0.192	0.320	0.160	0.192	0.320	0.160
160	0.150	0.250	0.125	0.150	0.250	0.125
200	0.120	-	-	0.120	-	-

DISCONNECTION TIME/CURRENT DATA STANDARD:

DISCONNECTION TIME (s)	60.00	10.00	5.00	1.00	0.40	0.10
In (A)	DISCONNECTION CURRENT (A)					
16	40.00	80.00	120.00	160.00	160.00	160.00
20	48.00	100.00	150.00	200.00	200.00	200.00
32	70.00	150.00	250.00	320.00	320.00	320.00
40	110.00	240.00	330.00	400.00	400.00	400.00
50	150.00	320.00	440.00	500.00	500.00	500.00
63	190.00	470.00	600.00	630.00	630.00	630.00
80	240.00	600.00	800.00	800.00	800.00	800.00
100	290.00	680.00	1000.00	1000.00	1000.00	1000.00
125	350.00	1000.00	1250.00	1250.00	1250.00	1250.00
160	480.00	1250.00	1600.00	1600.00	1600.00	1600.00
200	600.00	1600.00	2000.00	2000.00	2000.00	2000.00

MCCB LET-THROUGH ENERGY DATA I^2t (A^2sec) F-FRAME (FIXED TRIP)

FAULT LEVEL (A)	RATING										
	16A	20A	32A	40A	50A	63A	80A	100A	125A	160A	200A
45000	390,000	390,000	700,000	910,000	1,100,000	1,100,000	1,150,000	1,150,000	1,150,000	1,300,000	1,300,000
30000	350,000	350,000	600,000	750,000	830,000	830,000	920,000	920,000	920,000	1,100,000	1,100,000
25000	340,000	340,000	580,000	700,000	800,000	800,000	900,000	900,000	900,000	1,000,000	1,000,000
20000	310,000	310,000	480,000	580,000	650,000	650,000	700,000	700,000	700,000	800,000	800,000
16000	290,000	290,000	410,000	500,000	550,000	550,000	600,000	600,000	600,000	700,000	700,000
5000	120,000	120,000	130,000	140,000	145,000	145,000	148,000	148,000	148,000	150,000	150,000
3000	60,000	60,000	62,000	63,000	66,000	66,000	68,000	68,000	68,000	69,000	69,000
2000	35,000	35,000	35,000	35,000	35,000	35,000	35,000	35,000	35,000	35,000	35,000

MEMSHIELD 2 F FRAME

TYPE OF DEVICE = MOULDED CASE CIRCUIT BREAKER (MCCB)
INSULATION VOLTAGE = 690 Volts AC
FREQUENCY = 50/60 Hertz
SHORT CIRCUIT CATEGORY = Icu 25/45/65kA (415 Volts)

DISCONNECTION TIME/CURRENT DATA ADJUSTABLE S/C SET TO MIN:

DISCONNECTION TIME (s)	60.00	10.00	5.00	1.00	0.40	0.10
In (A)	DISCONNECTION CURRENT (A)					
50	165.00	300.00	300.00	300.00	300.00	300.00
63	250.00	378.00	378.00	378.00	378.00	378.00
80	350.00	480.00	480.00	480.00	400.00	480.00
100	450.00	600.00	600.00	600.00	600.00	600.00
125	700.00	750.00	750.00	750.00	750.00	750.00
160	800.00	960.00	960.00	960.00	960.00	960.00

DISCONNECTION TIME/CURRENT DATA ADJUSTABLE S/C SET TO MAX:

DISCONNECTION TIME (s)	60.00	10.00	5.00	1.00	0.40	0.10
In (A)	DISCONNECTION CURRENT (A)					
50	165.00	450.00	600.00	600.00	600.00	600.00
63	250.00	650.00	756.00	756.00	756.00	756.00
80	350.00	960.00	960.00	960.00	960.00	960.00
100	450.00	1050.00	1200.00	1200.00	1200.00	1200.00
125	700.00	1500.00	1500.00	1500.00	1500.00	1500.00
160	800.00	1850.00	1920.00	1920.00	1920.00	1920.00

MEMSHIELD 2 J FRAME

TYPE OF DEVICE = MOULDED CASE CIRCUIT BREAKER (MCCB)
INSULATION VOLTAGE = 690 Volts AC
FREQUENCY = 50/60 Hertz
SHORT CIRCUIT CATEGORY = Icu 36/65kA (415 Volts)

MAXIMUM EARTH LOOP IMPEDANCE Zs (OHMS):

In (A)	SOCKET OUTLET CIRCUITS (0.4 secs)		FIXED APPLIANCE CIRCUITS (5 secs)	
	Adjustable S/C Set to Min	Adjustable S/C Set to Max	Adjustable S/C Set to Min	Adjustable S/C Set to Max
200	0.200	0.100	0.200	0.100
250	0.160	0.080	0.160	0.080

DISCONNECTION TIME/CURRENT DATA ADJUSTABLE S/C SET TO MIN:

DISCONNECTION TIME (s)	60.00	10.00	5.00	1.00	0.40	0.10
In (A)	DISCONNECTION CURRENT (A)					
200	600.00	1200.00	1200.00	1200.00	1200.00	1200.00
250	1000.00	1500.00	1500.00	1500.00	1500.00	1200.00

DISCONNECTION TIME/CURRENT DATA ADJUSTABLE S/C SET TO MAX:

DISCONNECTION TIME (s)	60.00	10.00	5.00	1.00	0.40	0.10
In (A)	DISCONNECTION CURRENT (A)					
200	600.00	2400.00	2400.00	2400.00	2400.00	2400.00
250	1000.00	3000.00	3000.00	3000.00	3000.00	3000.00

MCCB LET-THROUGH ENERGY DATA I^2t (A^2sec) J-FRAME

FAULT LEVEL (A)	RATING		
	160A	200A	250A
65000	1,500,000	2,300,000	3,400,000
50000	1,300,000	2,200,000	3,100,000
36000	1,150,000	1,700,000	2,700,000
25000	1,000,000	1,400,000	2,400,000
16000	700,000	1,100,000	1,800,000
10000	420,000	620,000	1,150,000
5000	190,000	230,000	390,000
3000	90,000	95,000	125,000
2500	62,000	65,000	85,000

MEMSHIELD 2 K FRAME

TYPE OF DEVICE = MOULDED CASE CIRCUIT BREAKER (MCCB)
INSULATION VOLTAGE = 690 Volts AC
FREQUENCY = 50/60 Hertz
SHORT CIRCUIT CATEGORY = Icu 36/65kA (415 Volts)

MAXIMUM EARTH LOOP IMPEDANCE Zs (OHMS):

In (A)	SOCKET OUTLET CIRCUITS (0.4 secs)		FIXED APPLIANCE CIRCUITS (5 secs)	
	Adjustable S/C Set to Min	Adjustable S/C Set to Max	Adjustable S/C Set to Min	Adjustable S/C Set to Max
250	–	-	-	-
320	0.125	0.0625	0.125	0.0625
400	0.100	0.050	0.100	0.050

DISCONNECTION TIME/CURRENT DATA ADJUSTABLE S/C SET TO MIN:

DISCONNECTION TIME (s)	60.00	10.00	5.00	1.00	0.40	0.10
In (A)	DISCONNECTION CURRENT (A)					
250	-	-	-	-	-	-
320	900.00	1920.00	1920.00	1920.00	1920.00	1920.00
400	1500.00	2400.00	2400.00	2400.00	2400.00	2400.00

DISCONNECTION TIME/CURRENT DATA ADJUSTABLE S/C SET TO MAX:

DISCONNECTION TIME (s)	60.00	10.00	5.00	1.00	0.40	0.10
In (A)	DISCONNECTION CURRENT (A)					
250	-	-	-	-	-	-
320	900.00	2500.00	3840.00	3840.00	3840.00	3840.00
400	1500.00	4800.00	4800.00	4800.00	4800.00	4800.00

MCCB LET-THROUGH ENERGY DATA I^2t (A^2sec) K-FRAME

FAULT LEVEL (A)	RATING		
	250A	320A	400A
65000	3,500,000	4,300,000	5,500,000
50000	3,250,000	4,000,000	5,100,000
36000	2,700,000	3,400,000	4,000,000
30000	2,500,000	3,100,000	3,800,000
20000	2,000,000	2,500,000	3,000,000
16000	1,700,000	2,100,000	2,600,000
10000	1,000,000	1,200,000	1,500,000
5000	380,000	400,000	440,000
4000	220,000	240,000	250,000

MEMSHIELD 2 L FRAME THERMAL/MAGNETIC

TYPE OF DEVICE = MOULDED CASE CIRCUIT BREAKER (MCCB)
INSULATION VOLTAGE = 690 Volts AC
FREQUENCY = 50/60 Hertz
SHORT CIRCUIT CATEGORY = Icu 50kA (415 Volts)

MAXIMUM EARTH LOOP IMPEDANCE Zs (OHMS):

In (A)	SOCKET OUTLET CIRCUITS (0.4 secs)		FIXED APPLIANCE CIRCUITS (5 secs)	
	Adjustable S/C Set to Min	Adjustable S/C Set to Max	Adjustable S/C Set to Min	Adjustable S/C Set to Max
400	0.120	0.060	0.120	0.060
630	0.076	0.038	0.076	0.038
800	0.060	0.030	0.060	0.030

DISCONNECTION TIME/CURRENT DATA ADJUSTABLE S/C SET TO MIN:

DISCONNECTION TIME (s)	60.00	10.00	5.00	1.00	0.40	0.10
In (A)	DISCONNECTION CURRENT (A)					
400	1500.00	2000.00	2000.00	2000.00	2000.00	2000.00
630	2800.00	3150.00	3150.00	3150.00	3150.00	3150.00
800	4000.00	4000.00	4000.00	4000.00	4000.00	4000.00

DISCONNECTION TIME/CURRENT DATA ADJUSTABLE S/C SET TO MAX:

DISCONNECTION TIME (s)	60.00	10.00	5.00	1.00	0.40	0.10
In (A)	DISCONNECTION CURRENT (A)					
400	1500.00	4000.00	4000.00	4000.00	4000.00	4000.00
630	2800.00	6300.00	6300.00	6300.00	6300.00	6300.00
800	4000.00	8000.00	8000.00	8000.00	8000.00	8000.00

MCCB LET-THROUGH ENERGY DATA I^2t (A^2sec) L-FRAME (THERMAL/MAG)

FAULT LEVEL (A)	RATING		
	400A	630A	800A
50000	12,500,000	12,500,000	12,500,000
40000	10,000,000	10,000,000	10,000,000
35000	9,000,000	9,000,000	9,000,000
30000	7,800,000	7,800,000	7,800,000
20000	6,000,000	6,000,000	6,000,000
15000	4,200,000	4,200,000	4,200,000
10000	2,500,000	2,500,000	2,500,000

MEMSHIELD 2 L, M & N FRAME ELECTRONIC

TYPE OF DEVICE = MOULDED CASE CIRCUIT BREAKER (MCCB)
INSULATION VOLTAGE = 690 Volts AC
FREQUENCY = 50/60 Hertz
SHORT CIRCUIT CATEGORY = Icu 50kA (415 Volts)

MAXIMUM EARTH LOOP IMPEDANCE Zs (OHMS):

In (A)	SOCKET OUTLET CIRCUITS (0.4 secs)						FIXED APPLIANCE CIRCUITS (5 secs)					
	S/C Set to Min			S/C Set to Max			S/C Set to Min			S/C Set to Max		
	L Frame	M Frame	N Frame	L Frame	M Frame	N Frame	L Frame	M Frame	N Frame	L Frame	M Frame	N Frame
630	0.190	-	-	0.038	-	-	0.190	-	-	0.038	-	-
800	0.150	-	-	0.030	-	-	0.150	-	-	0.030	-	-
1000	-	0.120	-	-	0.024	-	-	0.120	-	-	0.024	-
1250	-	0.096	-	-	0.0192	-	-	0.096	-	-	0.0192	-
1600	-	-	0.075	-	-	0.015	-	-	0.075	-	-	0.015

DISCONNECTION TIME/CURRENT DATA L FRAME ELECTRONIC S/C SET TO MIN:

DISCONNECTION TIME (s)	60.00	10.00	5.00	1.00	0.40	0.10
In (A)	DISCONNECTION CURRENT (A)					
630	1260.00	1260.00	1260.00	1260.00	1260.00	1260.00
800	1600.00	1600.00	1600.00	1600.00	1600.00	1600.00

DISCONNECTION TIME/CURRENT DATA L FRAME ELECTRONIC S/C SET TO MAX:

DISCONNECTION TIME (s)	60.00	10.00	5.00	1.00	0.40	0.10
In (A)	DISCONNECTION CURRENT (A)					
630	2237.00	5292.00	6300.00	6300.00	6300.00	6300.00
800	2840.00	6720.00	8000.00	8000.00	8000.00	8000.00

DISCONNECTION TIME/CURRENT DATA M FRAME ELECTRONIC S/C SET TO MIN:

DISCONNECTION TIME (s)	60.00	10.00	5.00	1.00	0.40	0.10
In (A)	DISCONNECTION CURRENT (A)					
1000	2000.00	2000.00	2000.00	2000.00	2000.00	2000.00
1250	2500.00	2500.00	2500.00	2500.00	2500.00	2500.00

DISCONNECTION TIME/CURRENT DATA M FRAME ELECTRONIC S/C SET TO MAX:

DISCONNECTION TIME (s)	60.00	10.00	5.00	1.00	0.40	0.10
In (A)	DISCONNECTION CURRENT (A)					
1000	3500.00	8400.00	10000.00	10000.00	10000.00	10000.00
1250	4438.00	10500.00	12500.00	12500.00	12500.00	12500.00

MEMSHIELD 2 L, M & N FRAME ELECTRONIC	
TYPE OF DEVICE	= MOULDED CASE CIRCUIT BREAKER (MCCB)
INSULATION VOLTAGE	= 690 Volts AC
FREQUENCY	= 50/60 Hertz
SHORT CIRCUIT CATEGORY	= Icu 50kA (415 Volts)

DISCONNECTION TIME/CURRENT DATA N FRAME ELECTRONIC S/C SET TO MIN:						
DISCONNECTION TIME (s)	60.00	10.00	5.00	1.00	0.40	0.10
In (A)	DISCONNECTION CURRENT (A)					
1600	3200.00	3200.00	3200.00	3200.00	3200.00	3200.00

DISCONNECTION TIME/CURRENT DATA N FRAME ELECTRONIC S/C SET TO MAX:						
DISCONNECTION TIME (s)	60.00	10.00	5.00	1.00	0.40	0.10
In (A)	DISCONNECTION CURRENT (A)					
1600	5680.00	13440.00	16000.00	16000.00	16000.00	16000.00

MCCB LET-THROUGH ENERGY DATA I^2t (A^2sec) L-FRAME (ELECTRONIC)	
FAULT LEVEL (A)	RATING 630/800A
50000	13,000,000
40000	11,000,000
30000	9,000,000
20000	6,400,000
15000	5,000,000
10000	3,000,000

MCCB LET-THROUGH ENERGY DATA I^2t (A^2sec) M-FRAME (ELECTRONIC)	
FAULT LEVEL (A)	RATING 1000/1250A
65000	68,000,000
50000	50,000,000
40000	37,000,000
30000	25,000,000
20000	11,000,000

MCCB LET-THROUGH ENERGY DATA I^2t (A^2sec) N-FRAME (ELECTRONIC)	
FAULT LEVEL (A)	RATING 1600A
85000	88,000,000
65000	68,000,000
50000	50,000,000
40000	37,000,000
30000	25,000,000
20000	11,000,000

MEMSHIELD 2 ACB

TYPE OF DEVICE = AIR CIRCUIT BREAKER (ACB)
INSULATION VOLTAGE (Ui) (v) = 1000 Volts AC
FREQUENCY = 50 Hertz
SHORT CIRCUIT CATEGORY = Refer to ACB catalogue

MAXIMUM EARTH LOOP IMPEDANCE Zs (OHMS):

In (A)	SOCKET OUTLET CIRCUITS (0.4 secs)		FIXED APPLIANCE CIRCUITS (5 secs)	
	S/C Set to Min	S/C Set to Max	S/C Set to Min	S/C Set to Max
80	3.000	0.300	3.000	0.300
160	1.500	0.150	1.500	0.150
250	0.960	0.096	0.960	0.096
320	0.750	0.075	0.750	0.075
500	0.480	0.048	0.480	0.048
630	0.380	0.038	0.380	0.038
1000	0.240	0.024	0.240	0.024
1250	0.192	0.0192	0.192	0.0192
1600	0.150	0.015	0.150	0.015
2000	0.120	0.012	0.120	0.012
2500	0.096	0.0096	0.096	0.0096
3200	0.075	0.0075	0.075	0.0075
4000	0.060	0.006	0.060	0.006

DISCONNECTION TIME/CURRENT DATA S/C SET TO MIN:

DISCONNECTION TIME (s)	60.00	10.00	5.00	1.00	0.40	0.10
In (A)	DISCONNECTION CURRENT (A)					
80	80.00	80.00	80.00	80.00	80.00	80.00
160	160.00	160.00	160.00	160.00	160.00	160.00
250	250.00	250.00	250.00	250.00	250.00	250.00
320	320.00	320.00	320.00	320.00	320.00	320.00
500	500.00	500.00	500.00	500.00	500.00	500.00
630	630.00	630.00	630.00	630.00	630.00	630.00
1000	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00
1250	1250.00	1250.00	1250.00	1250.00	1250.00	1250.00
1600	1600.00	1600.00	1600.00	1600.00	1600.00	1600.00
2000	2000.00	2000.00	2000.00	2000.00	2000.00	2000.00
2500	2500.00	2500.00	2500.00	2500.00	2500.00	2500.00
3200	3200.00	3200.00	3200.00	3200.00	3200.00	3200.00
4000	4000.00	4000.00	4000.00	4000.00	4000.00	4000.00

DISCONNECTION TIME/CURRENT DATA S/C SET TO MAX:

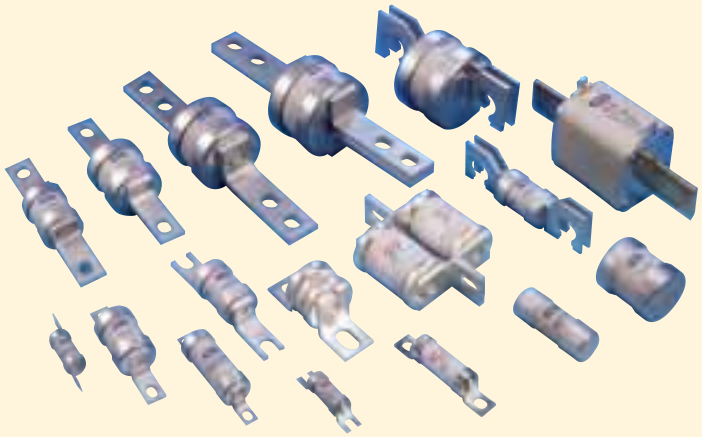
DISCONNECTION TIME (s)	60.00	10.00	5.00	1.00	0.40	0.10
In (A)	DISCONNECTION CURRENT (A)					
80	204.00	480.00	800.00	800.00	800.00	800.00
160	408.00	960.00	1600.00	1600.00	1600.00	1600.00
250	674.00	1500.00	2500.00	2500.00	2500.00	2500.00
320	816.00	1920.00	3200.00	3200.00	3200.00	3200.00
500	1275.00	3000.00	5000.00	5000.00	5000.00	5000.00
630	1605.00	3780.00	6300.00	6300.00	6300.00	6300.00
1000	2550.00	6000.00	10000.00	10000.00	10000.00	10000.00
1250	3188.00	7500.00	12500.00	12500.00	12500.00	12500.00
1600	4080.00	9600.00	16000.00	16000.00	16000.00	16000.00
2000	5100.00	12000.00	20000.00	20000.00	20000.00	20000.00
2500	6375.00	15000.00	25000.00	25000.00	25000.00	25000.00
3200	8160.00	19200.00	32000.00	32000.00	32000.00	32000.00
4000	10200.00	24000.00	40000.00	40000.00	40000.00	40000.00

MAXIMUM LET THROUGH ENERGY:

PROSPECTIVE SHORT CIRCUIT (kA)	0.1	0.2	0.5	1.0	2.0	5.0	10.0	20.0	35.0	40.0	50.0	65.0	85.0
In(A)	I^2t (A^2 sec)												
630	800	-	20000	80000	-	2000000	8000000	30000000	100000000	-	-	-	-
1250	-	3000	-	80000	-	2000000	8000000	30000000	-	120000000	-	320000000	-
1600	-	3000	-	80000	-	2000000	8000000	30000000	-	120000000	-	320000000	-
2000	-	3000	-	80000	-	2000000	8000000	30000000	-	120000000	-	320000000	-
2500	-	3000	-	80000	-	2000000	8000000	30000000	-	120000000	-	320000000	-
3200	-	-	-	-	300000	2000000	8000000	30000000	-	120000000	200000000	-	600000000
4000	-	-	-	-	300000	2000000	8000000	30000000	-	120000000	200000000	-	600000000

Paramount

HRC Cartridge



Eaton MEM HRC fuselinks are manufactured to exacting standards using precision assembly methods and undergo rigorous quality checking before dispatch including resistance testing all production. This ensures that performance will be consistent and conform with published characteristics within close tolerances. Type tests on Eaton MEM equipment have been performed using Eaton MEM fuselinks and the exclusive use of Eaton MEM fuselinks in Eaton MEM equipment will extend the warranty period to 3 years.

Eaton MEM industrial and general purpose fuselinks have a breaking range and utilization category gG which replaces the old class Q1 fusing factor. "g" indicates a full range breaking capacity fuselink and "G" indicates a fuselink for general application.

Eaton MEM motor circuit protection fuselinks have a breaking range and utilization category gM indicating a full range breaking capacity fuselink for the protection of motor circuits. These fuselinks have a dual current rating separated by the letter "M".

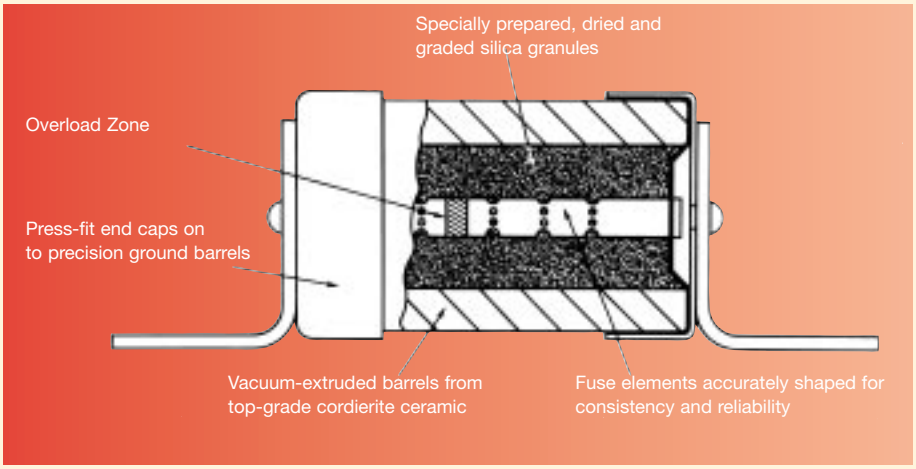
The lower current rating is the maximum continuous rating which also determines the rating and size of equipment to which the fuse is fitted. The higher current rating is the time current characteristic of the fuselink which determines its ability to withstand the motor starting current. Their selection frequently permits the use of lower rated switch and/or fusegear than would be the case using gG fuselinks with a consequent cost saving. Type gG fuselinks however may still be used and are the preferred option for assisted start motors where starting currents are reduced.

Technical information for these products is available from Eaton MEM's Customer Services Department.

Eaton MEM fuselinks are designed and manufactured in accordance with a Quality Management System in accordance with ISO 9001 assessed by BSI. Most fuselinks are ASTA Certified for a breaking capacity of 80kA at 415V or 550V a.c. and are endorsed ASTA 20 CERT showing compliance with the rules of the ASTA 20 scheme which includes assessment of the Quality Management System to ISO 9002 and detailed auditing of fuselink manufacture.

Eaton MEM have for many years participated in developing and influencing fuse standards through EIEMA and BSI at national level and IEC at international level and therefore are able to produce designs incorporating forthcoming changes to standards.

Fuselinks & Fuse Units



Fuse barrels are extruded under vacuum to prevent the formation of air pockets, before being fired and precision ground.

The fuse elements are designed and manufactured using the most suitable element materials in order to obtain optimum performance.

The current rating is determined by the cross-sectional area of elements used and the watts of the fuse.

The thickness of the 'neck' is calculated to determine the energy let-through of the fuse, whilst the number of 'necks' determines the voltage rating.

Eaton MEM manufactures high quality fuse links covering the vast majority of industrial and domestic requirements.

Suitable fuse links are provided for all the Company's wide range of HRC fuse-protected products from 250V switchfuses and consumer's control units to 800A TPN fuse switches. In addition, industrial fuses are available up to 1600A with specialist ranges to cater for such applications as street lighting and house service cut-outs.

Excellence is the Norm:

Design, manufacture, and quality control are in accordance with the rigorous requirements of BSENISO 9001:1994.

Eaton MEM, HRC Fuse Selection:

In steady-load circuits, the HRC fuse link selected should be equal to – or slightly higher than – the amperage of the circuit: or of the apparatus being controlled, whichever is the lower.

Fluctuating-load circuits (e.g. – motor, capacitor or transformer circuits) are dealt with individually below.

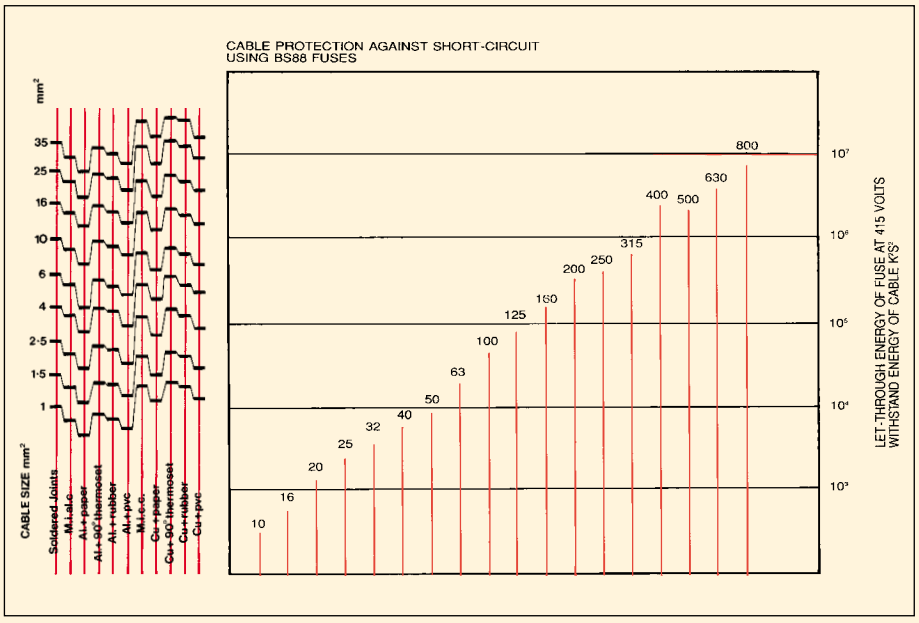
Protection of Cables

- ***The following graphs demonstrate the levels of protection against short circuit provided by BS88 fuses for various sizes and types of cable in common use.***
- ***To establish level of fuse protection required for a given size and type of cable.***

Follow appropriate red vertical rule to its intersection with the black line which indicates cable size required (e.g, –2.5mm²) project this level horizontally to the right and read off fuse rating.

- ***To establish required size of given cable for known value of fuse needed to provide short-circuit protection.***

From top of vertical line applicable to selected fuse (e.g.–100A) project horizontally to the left and read off cable size.



Paramount HRC Fuselinks

Protection Against Electric Shock, High Ambient Air Temperature

PROTECTION AGAINST ELECTRIC SHOCK:

Fuses may be used for protection against electric shock by indirect contact – i.e., faults to exposed metalwork of the installation. The HRC fuse characteristic will determine the permissible earth loop impedance figure and relevant figures for certain sizes of BS88 fuse, taken from the 16th Edition of the IEE Wiring Regulations Table 41D is reproduced below. The figures are derived from the BS88 time/current zones to achieve disconnection within 5 seconds for fixed equipment circuits. The published figures are relevant to 240 volt-to-earth systems and should be multiplied by the ratio Uo/240 for any alternative voltage-to-earth (Uo).

TABLE 41D

Maximum earth fault loop impedance (Z_s) for 5s disconnection time with U_o240V (see Regulations 413-02-13 and 413-02-14)

(A) GENERAL PURPOSE (gG) FUSES TO BS88 PARTS 2 AND 6

Rating (Amperes)	6	10	16	20	25	32	40	50				
Z_s (ohms)	14.1	7.74	4.36	3.04	2.40	1.92	1.41	1.09				
Rating (Amperes)	63	80	100	125	160	200	250	315	400	500	630	800
Z_s (ohms)	0.86	0.60	0.44	0.35	0.27	0.20	0.17	0.12	0.094	0.067	0.055	0.035

(B) FUSES TO BS 1361

Rating (Amperes)	5	15	20	30	45	60	80	100
Z_s (ohms)	17.1	5.22	2.93	1.92	1.00	0.73	0.52	0.38

Actual Eaton MEM figures for individual fuses available on request.

HIGH AMBIENT AIR TEMPERATURE:

Eaton MEM HRC fuse links to BS88: Part 2:1988 operate at their stated rating in ambient air temperatures not exceeding 35ºC, as required by the standard. ('Ambient air temperatures' are assumed to be temperatures within the enclosures not exceeding 15º higher than the outside ambient). The following table indicates maximum permissible load currents applicable in high ambient situations, against nominal fuse ratings.

DE-RATED CURRENTS AT VARIOUS AMBIENTS:

2A – 20A No De-Rating up to and including 60º ambient.

LIST NO	MAX CURRENT AT AMBIENT TEMPERATURE				
	40ºC	45ºC	50ºC	55ºC	60ºC
2SA2	2	2	2	2	2
4SA2	4	4	4	4	4
6SA2	6	6	6	6	6
8SA2	8	8	8	8	8
10SA2	10	10	10	10	10
16SA2	16	16	16	16	16
20SA2	20	20	20	20	20
25SA2	25	25	25	25	25
32SA2	32	32	32	30	28
20SA2M25	20	20	20	20	20
20SA2M32	20	20	20	20	20
2SB3	2	2	2	2	2
4SB3	4	4	4	4	4
6BS3	6	6	6	6	6
8SB3	8	8	8	8	8
10SB3	10	10	10	10	10
16SB3	16	16	16	16	16
20SB3	20	20	20	20	20
25SB3	25	25	25	25	25
32SB3	32	32	31	29	27
32SB3M40	32	32	32	32	29
32SB3M50	32	32	32	32	32
32SB3M63	32	32	32	32	32

Paramount HRC Fuselinks

High Ambient Air Temperature

LIST NO	MAX CURRENT AT AMBIENT TEMPERATURE				
	40°C	45°C	50°C	55°C	60°C
40SB4	40	40	40	39	36
50SB4	50	50	50	49	45
63SB4	63	63	63	62	58
63SB4M80	63	63	63	63	63
63SB4M100	63	63	63	63	63
80SD5	80	80	80	80	80
100SD5	100	100	100	93	86
100SD5M125	100	100	100	100	100
100SD5M160	100	100	100	100	100
80SF5	80	80	80	80	77
100SF5	100	100	100	100	92
100SF5M160	100	100	100	100	100
125SD6	125	125	125	125	125
160SD6	160	160	160	160	147
200SD6	200	200	200	185	171
200SD6M250	200	200	200	200	200
125SF6	125	125	125	125	125
160SF6	160	160	160	160	147
200SF6	200	200	200	185	171
200SF6M250	200	200	200	200	200
250SF7	250	250	244	228	210
315SF7	315	315	293	274	254
250SG7	250	250	250	250	234
315SG7	314	315	293	275	254
355SF8	355	355	338	317	293
400SF8	400	386	364	341	316
355SH8	355	355	342	320	296
400SH8	400	400	378	353	327
450SH9	450	450	450	450	431
500SH9	500	500	500	470	435
560SH9	560	560	529	495	459
630SH9	630	614	579	542	502
450SY9	450	444	419	392	363
500SY9	500	490	462	432	340
630SY9	569	540	509	476	441
710SH10	670	636	599	561	519
800SH10	741	703	663	620	574
710SY10	679	644	607	568	526
800SY10	773	733	692	647	599
16SP	16	16	16	16	16
20SP	20	20	20	20	20
25SP	25	25	25	25	25
32SP	32	32	32	32	32
40SP	40	40	40	40	40
50SP	50	50	50	50	50
63SP	63	63	61	58	53

Paramount HRC Fuselinks

Transformer, Fluorescent Lighting & Capacitor Circuits. Discrimination & Back-up Protection

TRANSFORMER AND FLUORESCENT LIGHTING CIRCUITS:

To cater for inrush currents, the fuse link to be provided should have a rating approximately twice the transformer primary current: or the total current required by the maximum number of fluorescent lights to be switched simultaneously.

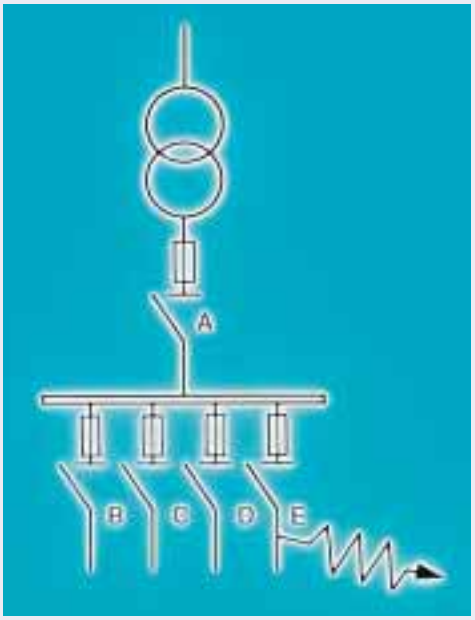
CAPACITOR CIRCUITS:

Three-phase power factor correction capacitors also have transient high-inrush characteristics. In addition, fuse protection needs to take into account circuit harmonics. Practical experience has shown that a fuse link rated at 50% higher than the rated capacitor current provides a satisfactory solution.

DISCRIMINATION BETWEEN FUSE LINKS:

Discrimination is achieved between major (upstream) and minor fuses if the major fuse remains unaffected when the minor fuse operates under maximum fault conditions.
To achieve this, the total I^2t of the minor fuse must be less than the pre-arcing I^2t of the major fuse.
Eaton MEM fuse links to BS88: Part 2: 1988 will discriminate on a 2:1 ratio between major and minor current ratings. In practical terms this ratio will ensure adequate discrimination at all levels of fault current, but characteristic curves (see page 55 onwards) may be used to calculate closer ratios, where necessary, when the fault current is small and results in the fuse operating in more than approximately 0.02 seconds.
For larger short-circuit currents, which involve the fuse operating in less than 0.01 seconds (1/2 cycle) appropriate total and pre-arcing I^2t figures can be established from the tables provided adjacent to each characteristic curve where appropriate.

EXAMPLE



Concept

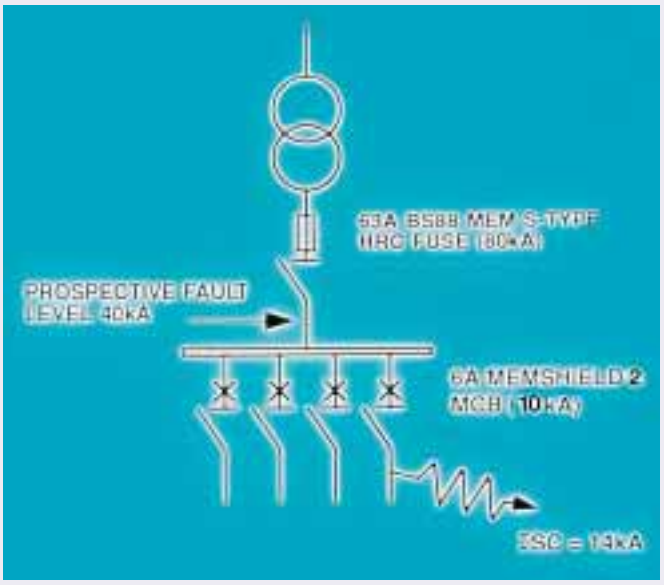
Short circuit occurs at E

A" remains unaffected

E" blows only, ensuring supply to B, C and D

BACK-UP PROTECTION:

Suitable S-Type Eaton MEM fuse links to provide back-up protection for Memshield 2 moulded case circuit breakers are detailed in the moulded case circuit breaker section of this brochure.



EXAMPLE

By installing BS88 Eaton MEM S-Type HRC fuse (80kA breaking capacity) at the upstream end of the installation and with an Isc of 40kA on the busbars it is possible to install Memshield 2 Type B, C or D, characteristic 1 - 63A MCBs (10kA breaking capacity) on the outgoing lines.

Paramount HRC Fuselinks

Motor Circuit Protection,

Co-ordination with short circuit Protective Devices

MOTOR CIRCUIT PROTECTION

Eaton MEM S-Type industrial bolted pattern fuselinks conform with BS88: Part 2: 1988 and have a breaking range and utilisation category of gG (full range breaking capacity for general applications). They are ASTA certified for a breaking capacity of 80kA at 415 and 550V ac.

Motor circuit protection fuselinks having a breaking range and utilisation category of gM (full range breaking capacity for the protection of motor circuits) are available as an extension of the industrial range. Their use in certain circumstances permits savings in the size of associated switchgear. This range of fuselinks are ASTA certified for a breaking capacity of 80kA at 415V ac.

These fuselinks are suitable for the back-up protection in motor circuits, having excellent time lag characteristics and high rupturing capacity.

The following tables should assist in selection of suitable fuse links. The figures are based on the assumption that the starting condition is 8 x f.l.c for 6 seconds d.o.l. and 4 x f.l.c. for 12 seconds star-delta. Motor kW figures are based on 415V 3-phase.

MOTOR RATING			D.O.L STARTING		ASSISTED START
kW	HP	APPROX. f.l.c. AMPS	STANDARD FUSELINK AMPS	MOTOR CIRCUIT FUSELINK	STANDARD FUSELINK AMPS
0.19	0.25	0.7	4		2
0.37	0.5	1.3	6		4
0.55	0.75	1.6	6		4
0.75	1.0	1.8	10		4
1.1	1.5	2.6	10		6
1.5	2.0	3.4	16		10
2.2	3.0	5.0	16		10
3.0	4.0	6.5	20		16
4.0	5.5	8.0	20		16
5.5	7.5	11.0	32	20M32	16
7.5	10	15	40	32M40	20
11.0	15	22	50	32M50	32
15.0	20	28	63	32M63	40
18.5	25	36	80	63M80	40
22	30	39	80	63M80	50
30	40	52	100	63M100	63

MOTOR RATING			D.O.L STARTING		ASSISTED START
kW	HP	APPROX. f.l.c. AMPS	STANDARD FUSELINK AMPS	MOTOR CIRCUIT FUSELINK	STANDARD FUSELINK AMPS
37	50	69	160	100M160	100
45	60	79	160	100M160	100
55	75	96	200	100M200	125
75	100	135	250	200M250	160
90	125	156	250	200M250	160
110	150	189	315	200M315	200
132	175	224	400	315M400	250
150	200	255	400	315M400	315
160	220	275	450		315
185	250	318	500		355
200	270	339	500		355
220	300	374	560		400
280	375	460	630		500
295	400	500	710		500
315	430	535	710		560
355	483	580	710		630
400	545	646	800		710
450	612	725	1000		800

Characteristic curves for S-Type motor rated fuses appear on page 57.

IEC 60947-4-1 CO-ORDINATION WITH SHORT CIRCUIT PROTECTIVE DEVICES:

The rated conditional short-circuit current of contactors and starters backed up by short-circuit protective device(s) (SCPD); combination starters and protected starters shall be verified by short-circuit tests as specified.

These tests are mandatory.

Type '1' co-ordination requires that under short-circuit conditions the contactor or starter shall cause no danger to persons or the installation and may not be suitable for further service without repair or replacement of parts.

Type '2' co-ordination requires that under short-circuit conditions the contactor or starter shall cause no danger to persons or the installation and shall be suitable for further use. The risk of contact welding is recognised, in which case the manufacturer shall indicate the measures to be taken as regards the maintenance of the equipment.

Note: Use of an SCPD not in compliance with the manufacturers recommendations may invalidate the co-ordination.

The general requirement for short circuit tests is that contactors and starters intended to be used in enclosures shall be tested in the smallest enclosure stated by the manufacturer.

See table on p84 for appropriate Eaton MEM HRC fuses providing Type 2 co-ordination to ADS7 starters.

Paramount HRC Fuselinks

Type 2 Co-ordination & ADS7 Starters

The back up fuses quoted give type 2 co-ordination as defined in BSEN 60947-4-1 up to 80kA prospective at 415V 3ph. In selected cases it is possible to use Memshield 2 miniature circuit breakers to provide back up protection for automatic starters up to 10kA prospective at 415V 3 phase.

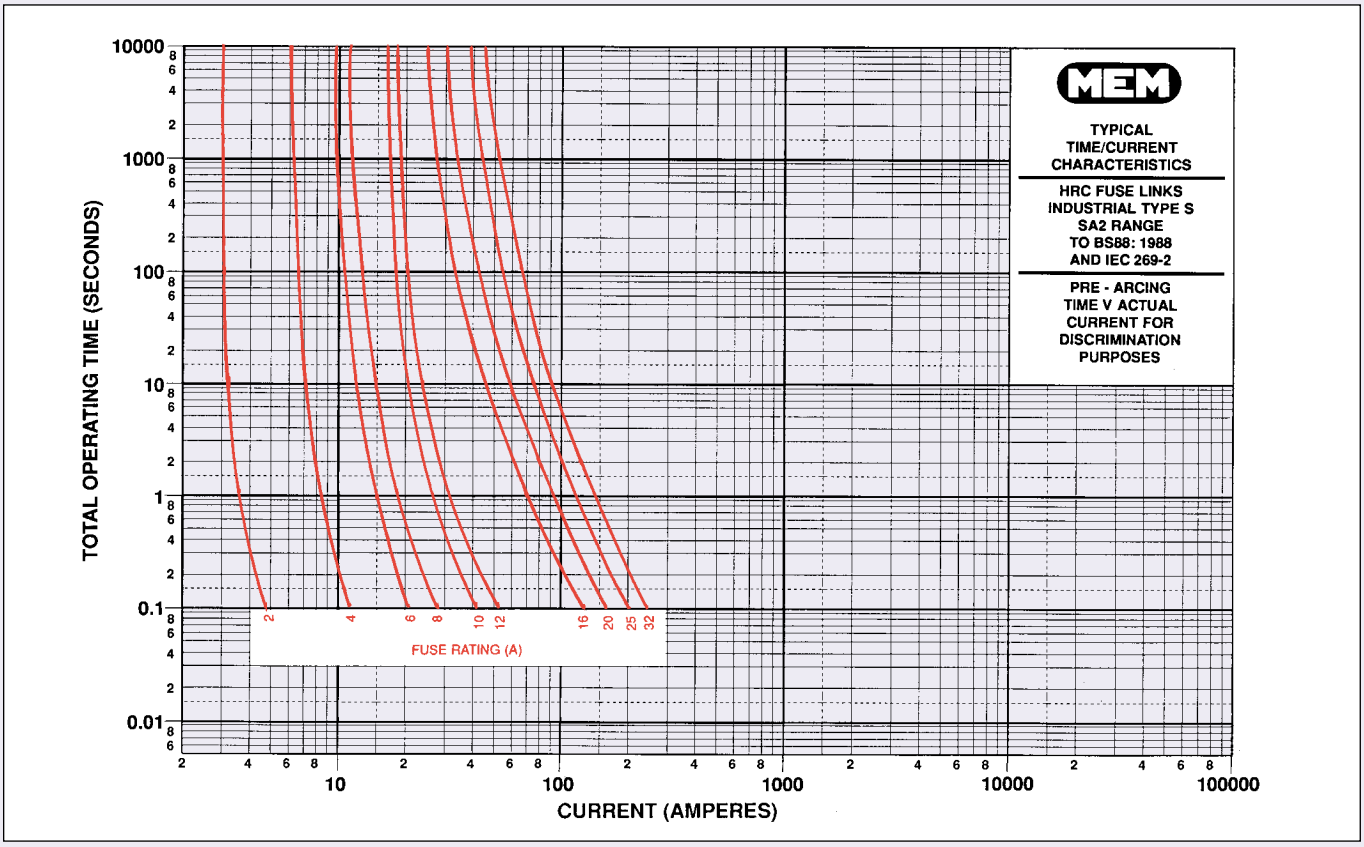
STARTER TYPE	OVERLOAD RELAY	BACK-UP PROTECTION		
		MAX HRC	MEMSHIELD 2 MCBS	
	CURRENT RANGE A	FUSE, MEM 'S' TYPE, A	TYPE C	TYPE D
Direct-on-line	0.15 – 0.22	2	MCH306	MDH306
380 ... 415V	0.22 – 0.33	2	MCH306	MDH306
3-phase	0.33 – 0.50	2	MCH306	MDH306
	0.50 – 0.74	4	MCH306	MDH306
	0.74 – 1.11	6	MCH306	MDH306
	1.11 – 1.66	6	MCH306	MDH306
	1.66 – 2.50	10	MCH306	MDH306
	2.50 – 3.70	16	MCH310	MDH306
	3.70 – 5.60	20	MCH316	MDH310
	5.60 – 8.40	20M25	MCH320	MDH316
	8.40 – 11.90	20M32	MCH320	MDH320
	11.40 – 16.00	32M40	MCH340	MDH332
	16.00 – 23.00	32M50	MCH340	MDH332
	23.00 – 33.00	63M80	MCH363	MDH340
Direct-on-line	0.74 – 1.11	6	MCH106	MDH106
220 ... 240V	1.11 – 1.66	6	MCH106	MDH106
single phase	1.66 – 2.50	10	MCH110	MDH106
	2.50 – 3.70	16	MCH110	MDH106
	3.70 – 5.60	20	MCH116	MDH110
	5.60 – 8.40	20M25	MCH120	MDH116
	8.40 – 11.90	20M32	MCH132	MDH120
	11.40 – 16.00	32M40	MCH150	MDH132
Star-Delta	4.80 – 6.40	16	MCH310	MDH310
380 ... 415V	6.40 – 9.70	20	MCH316	MDH316
3-phase	9.70 – 14.50	20M25	MCH320	MDH320
	14.50 – 20.60	20M32	MCH340	MDH332
	19.70 – 27.70	32M40	MCH350	MDH332
	26.00 – 42.00	32M63	MCH363	–
	38.00 – 57.00	63M80	–	–

Current range must be selected to include actual motor rated full load current.

STARTER TYPE	STARTER SIZE	BACK-UP PROTECTION MAX HRC FUSE, MEM 'S' TYPE, (A)
Heavy duty contactor	22DSB	63M100
starters. Direct-on-line	30DSB	100M160
380/550V 3-phase	37DSB	100M160
	55DSB	200
	90DSB	250
Heavy duty contactor	30YSB	63M100
starters. Star-delta	45YSB	63M100
380/550V 3-phase	55YSB	100M160
	75YSB	100M160
	90YSB	200

Paramount HRC Fuselinks

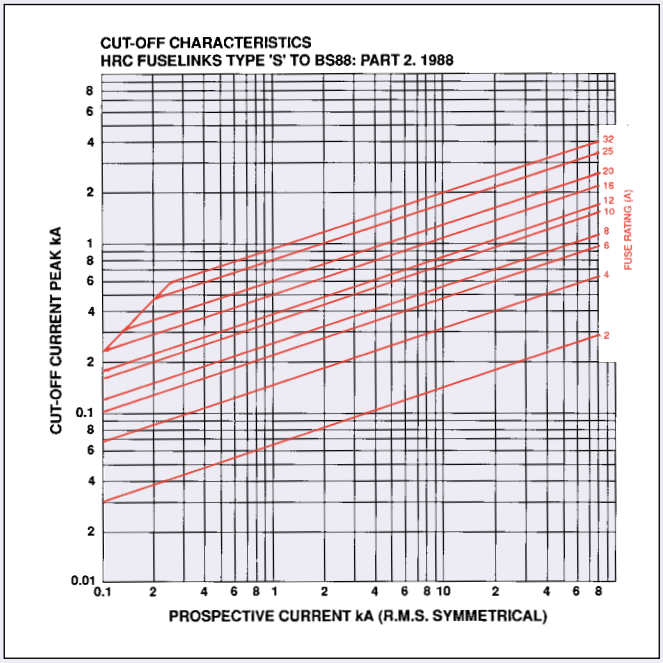
Typical Time / Current & Cut-off Current Characteristic



I²t CHARACTERISTICS

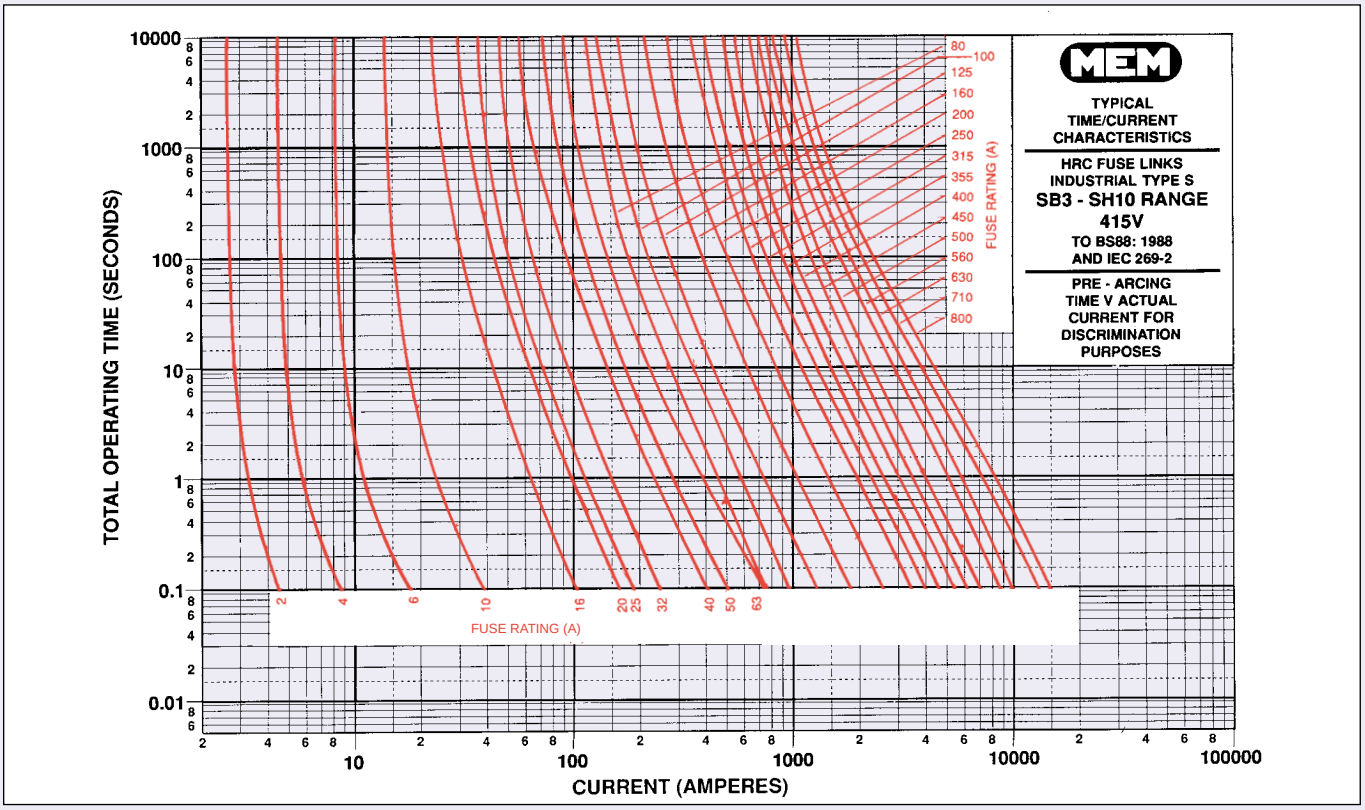
Type S fuses SA2 range

RATING (AMPERES)	I²t PRE-ARCING	I²t TOTAL @ 240 VOLTS	I²t TOTAL @ 415 VOLTS
2	1	4	5
4	10	21	27
6	35	74	95
8	55	82	105
10	135	190	245
12	190	275	355
16	95	205	360
20	160	340	600
25	375	820	1450
32	600	1300	2250



Paramount HRC Fuselinks

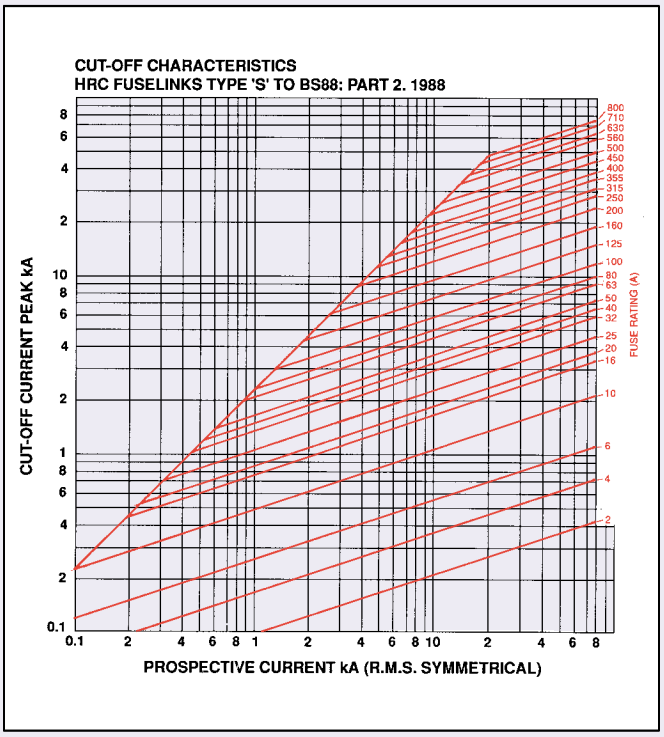
Typical Time / Current & Cut-off Current Characteristic



I²t CHARACTERISTICS

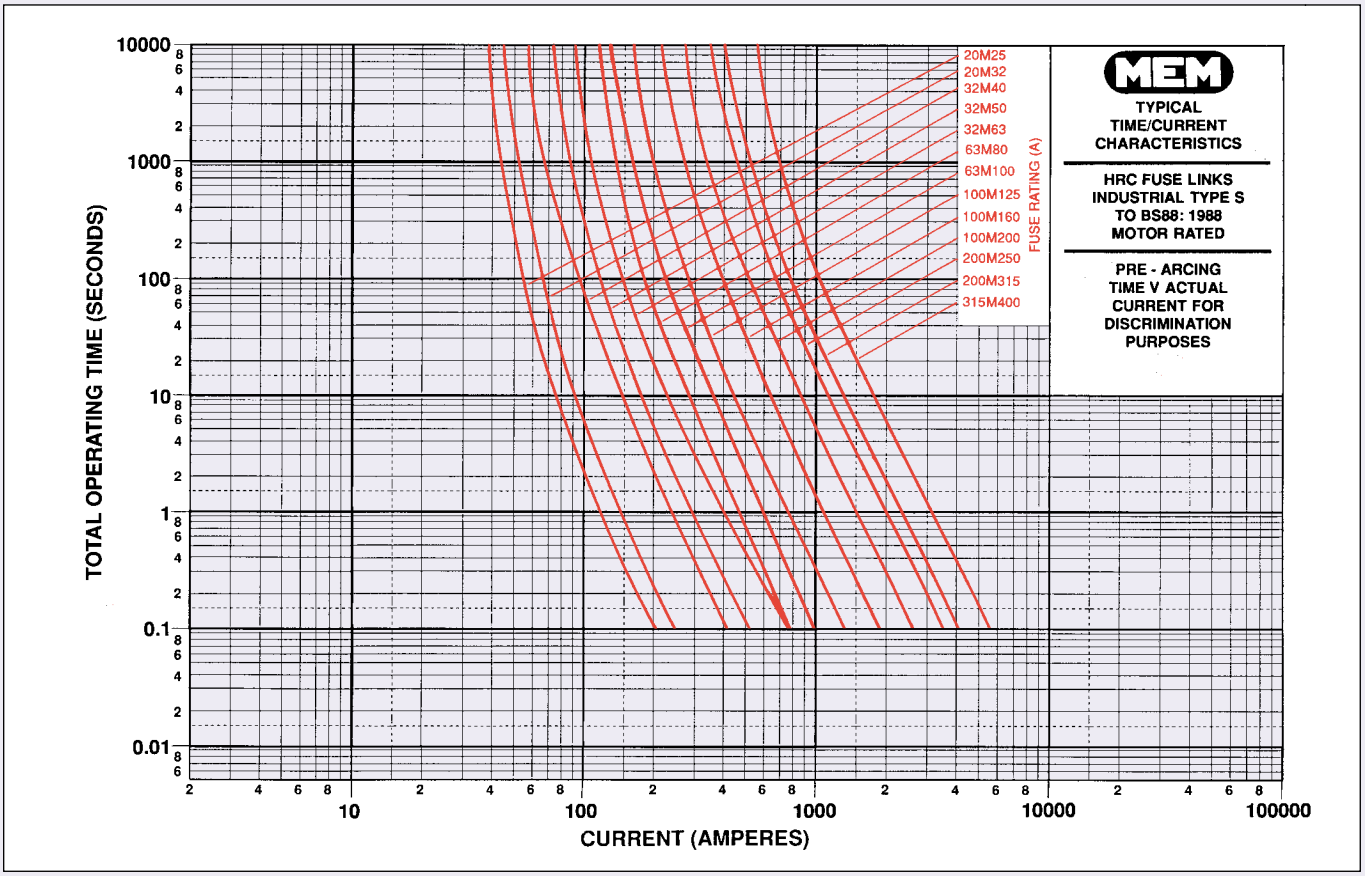
Type S fuses SB3 range and above

RATING (AMPERES)	I²t PRE-ARCING	I²t TOTAL @ 240 VOLTS	I²t TOTAL @ 415 VOLTS
2	2	3	4
4	10	15	22
6	34	53	75
10	188	291	415
16	207	405	696
20	367	720	1240
25	621	1220	2090
32	1190	2330	4010
40	2480	4420	7020
50	3310	5880	9350
63	5880	10500	16600
125	30000	51000	75500
160	58500	99000	145000
200	120000	205000	300000
250	210000	360000	530000
315	270000	460000	680000
355	365000	620000	915000
400	480000	820000	1200000
450	755000	1300000	1900000
500	1100000	1850000	2700000
560	1200000	2400000	4000000
630	1550000	3100000	5150000
710	3400000	5850000	8700000
800	4200000	7200000	10500000



Paramount HRC Fuselinks

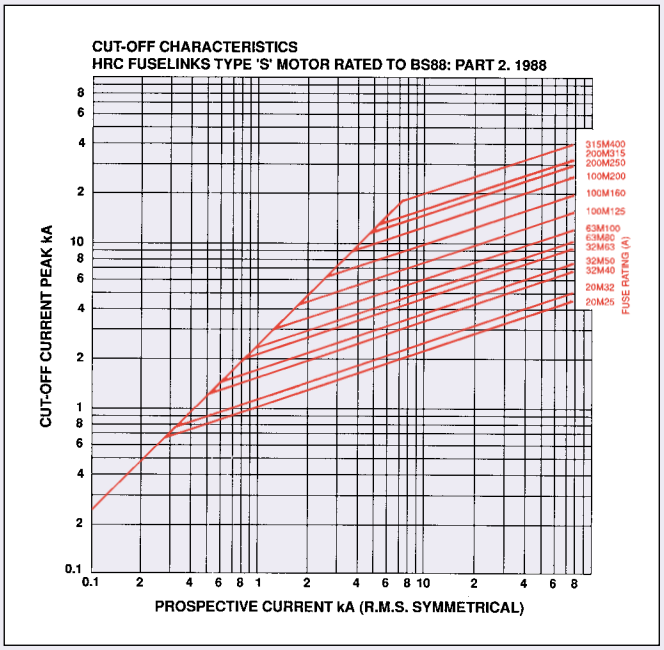
Typical Time / Current & Cut-off Current Characteristic



I^2t CHARACTERISTICS

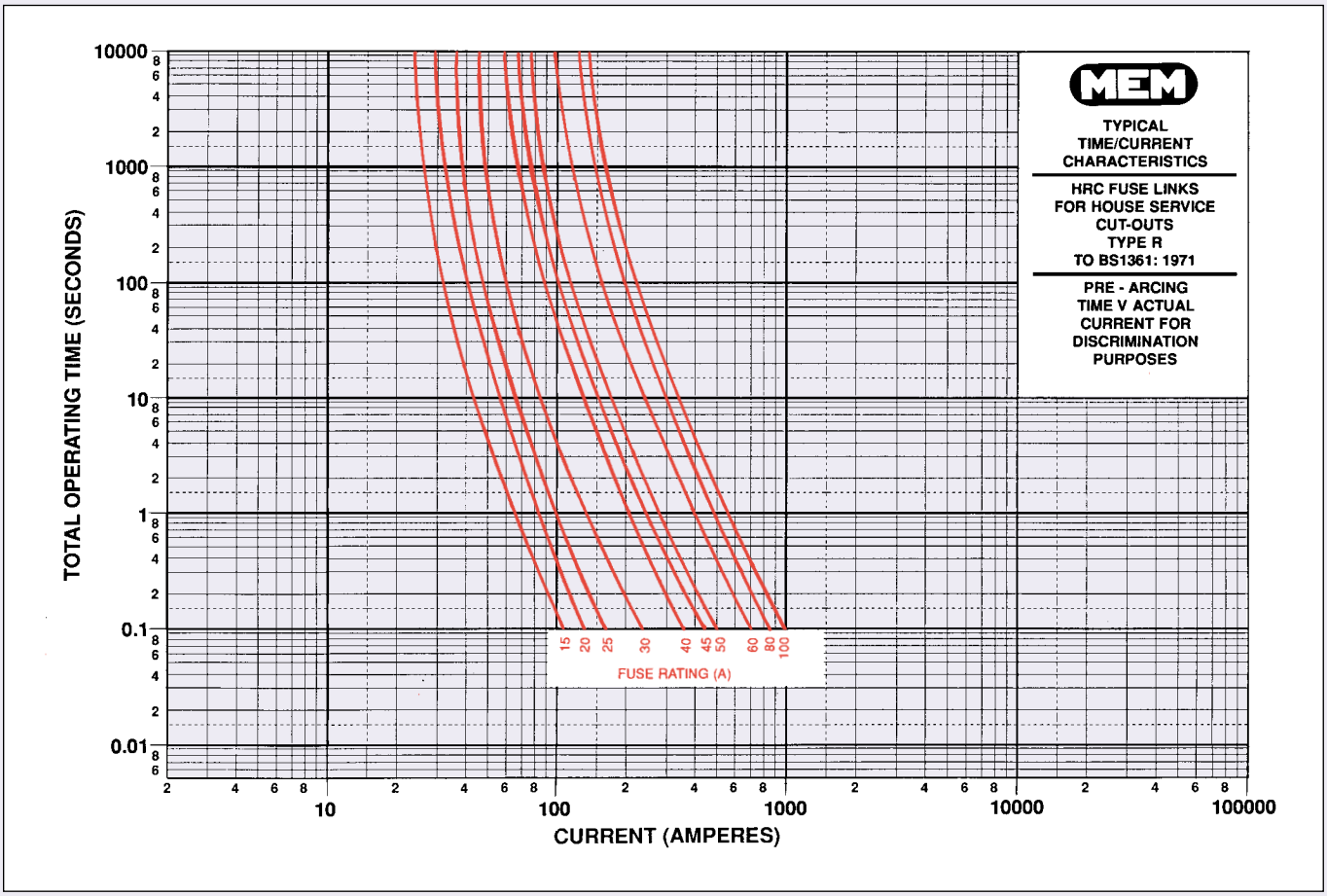
Type S motor circuit fuses 20M25 – 315M400

RATING (AMPERES)	I^2t PRE-ARCING	I^2t TOTAL @ 240 VOLTS	I^2t TOTAL @ 415 VOLTS
20M25	375	820	1450
20M32	600	1300	2250
32M40	2480	4420	7020
32M50	3310	5880	9350
32M63	5880	10500	16600
100M125	30000	51000	75500
100M160	58500	99000	145000
100M200	120000	205000	300000
200M250	210000	360000	530000
200M315	270000	460000	680000
315M400	480000	820000	1200000



Paramount HRC Fuselinks

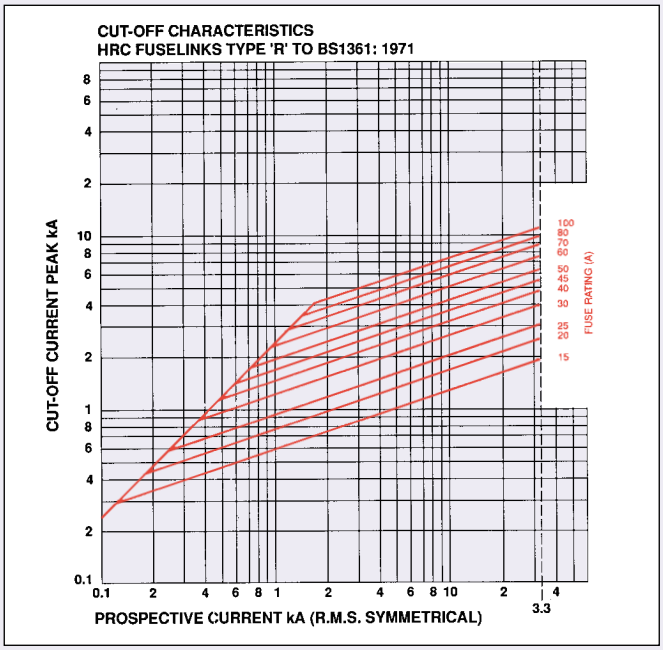
Typical Time / Current & Cut-off Current Characteristic



I²t CHARACTERISTICS

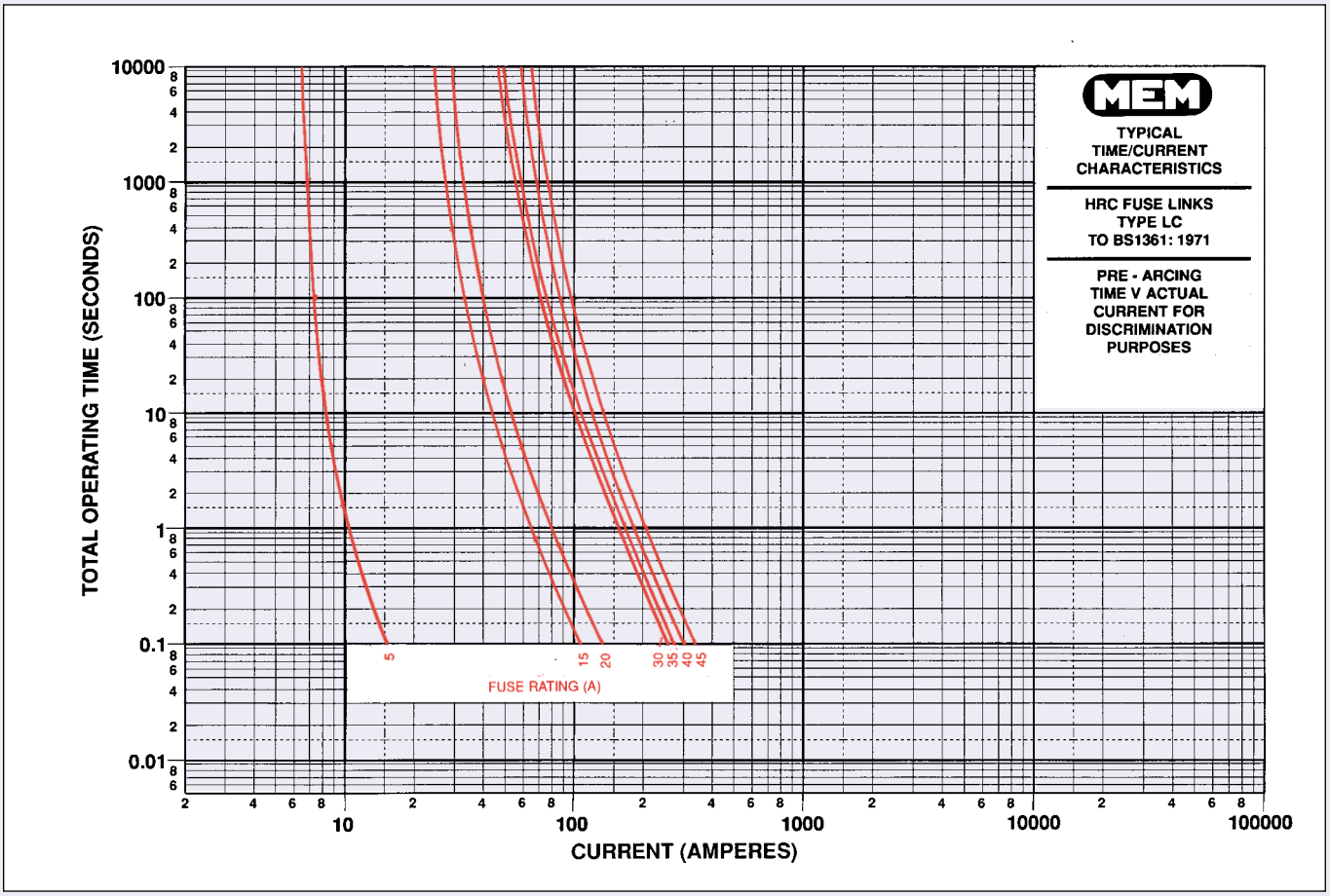
Type R fuses

RATING (AMPERES)	I²t PRE-ARCING	I²t TOTAL @ 240 VOLTS	I²t TOTAL @ 415 VOLTS
15	92	210	382
20	207	472	860
25	368	839	1530
30	826	1880	3430
40	1470	3350	6100
45	2300	5230	9530
50	3310	7530	13700
60	9180	20900	38100
80	13200	30100	54900
100	15500	27500	42000



Paramount HRC Fuselinks

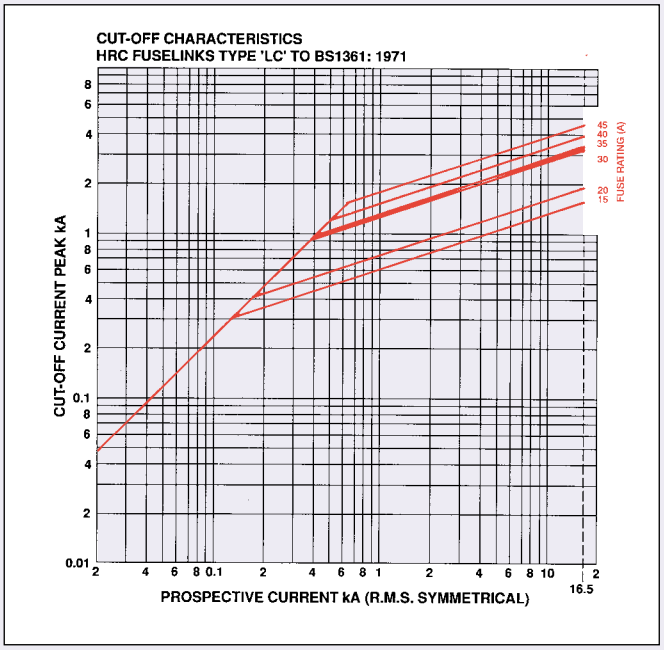
Typical Time / Current & Cut-off Current Characteristic



I^2t CHARACTERISTICS

Type LC, LCS fuses

RATING (AMPERES)	I^2t PRE-ARCING	I^2t TOTAL @ 240 VOLTS	I^2t TOTAL @ 415 VOLTS
5LC	26	51	–
15LC	92	494	–
20LC	163	586	–
30LC	1020	3450	–
35LCS	825	1640	–
40LCS	1470	2930	–
45LCS	1730	6470	–



Complete Motor Control

Selecting

The Correct Motor Starter

SELECTION OF STARTERS

Motor starters have two basic forms of operation: either automatic or manual.
Manual starters are generally more economic but less versatile and are normally only suitable for infrequent starting of smaller motors.
Automatic starters are rated for frequent duty, high mechanical durability and electrical life with the facility for remote control.
Eaton MEMs comprehensive range of starters, covers the vast majority of motor starting applications up to 90kW.
Eaton MEMs Specials Department is equipped to provide additional types for special applications – e.g. two-speed d.o.l. starters for dual wound and tap wound motors; single-phase series parallel and split-phase starters; plus numerous variants on standard catalogue items to special order.

SINGLE-PHASE OR THREE-PHASE ?

The motor rating plate will tell you whether operation is by single-phase (e.g. 220/240V~, 50Hz, 1ph) or three-phase (e.g. 380/415V~, 50Hz, 3ph) supply. It will also provide:

a) **kW/hp of motor** which is needed to select a starter of the correct rating.
Modern motors are rated in kW (kilowatts) which indicates the output power of the motor. The switching capacity of the starter must not be less than this figure. Published data for the starter will list its kW rating against the duty category AC-3. Older motors may be rated in hp only, in which case the power in kW = hp x 0.746. kW/hp equivalents are given on pages 67.

b) **Full load current** (f.l.c.) which you also need to ensure that the starter selected is fitted with an appropriately-rated overload device.
Starters in the Eaton MEM range are more commonly found in three-phase applications, but are perfectly suitable for single-phase use. However, wiring these starters for single-phase use requires different connections – see page 65.

SINGLE-PHASE STARTERS

Having established the rating and f.l.c. required, it is essential to consider the type of duty which the starter will be required to perform. The following guide also includes reference to the pages on which typical kW/hp and current range figures are given for Eaton MEM starters used in single-phase applications.

NOTE THAT THESE FIGURES DIFFER SIGNIFICANTLY FROM THE VALUES APPLICABLE TO 3-PHASE USE.

The current taken by single-phase motors of a given kW rating is considerably higher than for a three-phase motor of the same kW rating, simply because power is supplied by only one live conductor instead of three. Therefore, the current for 240V

Gear Guide

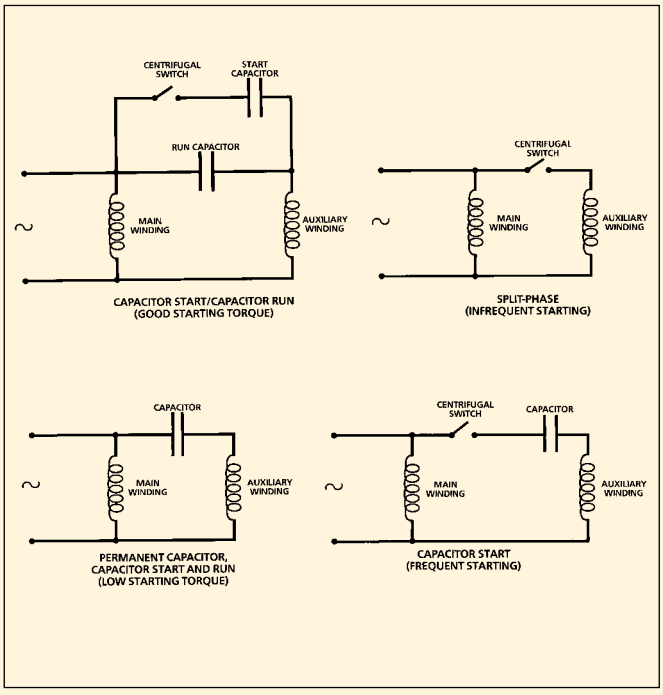
TYPE DUTY	TYPICAL APPLICATIONS	SUITABLE EATON MEM STARTER	MANUAL OR CONTACTOR STARTER
Intermittent starting of single-phase motors to 2.2kW max, 220/240V (Max. f.l.c. 16A)	Office machinery, commercial kitchen equipment, air conditioning units, for more frequent manual operation. Areas requiring higher IP rating	-	Manual
Frequent starting of single-phase motors to 4kW max, 220/240V (Max. f.l.c. 33A)	Automatic control by remote switching (limit switches, float switches etc). Frequent local (pushbutton) operation	ADS7	Contactor

1-phase is at least three times higher than for 415V 3-phase.

These types may be switched directly with manual or automatic starters. Single-phase reversing starters and starters with more complex windings (e.g. series/parallel connection) can be produced by Eaton MEMs Specials Department. In these cases, it is important to provide confirmation of the motor winding configuration, or at least the motor manufacturer's type reference, since there is a wide variety of single-phase motor types.

Small capacitor squirrel cage motors have a centrifugal switch for opening the starting winding or capacitor and a standard direct-on-line starter is suitable for this function. Care must be taken to ensure the starter is connected in accordance with the instructions for single phase applications.

On larger motors, series parallel switching is the most common and a special starter is required, which can be either manual or automatic. In addition there are split-phase motors having various switching configurations and a connection diagram is often necessary to ensure the correct starter is supplied.



Selecting the Correct Motor Starter

Single-phase or Three-phase?

THREE-PHASE STARTERS

Again, in addition to kW rating, voltage and frequency, you need to establish the actual motor rated full load current to select a starter with the appropriate overload device. If f.l.c. is not known, use the kW (hp) motor rating to establish a typical figure from the table on page 63. You also need to know:

a) What type of duty is the starter required to perform?
b) Is there a requirement for reduced voltage starting?
c) Is the starter intended for local or automatic control?

Let us take these in turn.

A) TYPE OF DUTY

As in single-phase operation, a manual starter used in three-phase applications is suitable for infrequent or intermittent starting of small motors. For frequent duty requiring high mechanical durability, long electrical life and the added facility of remote control operation (as outlined in (c) below), a contactor starter is required. As an indication of the mechanical performance levels to which they are tested, an ADS7 contactor must be able to achieve at least 5 x 10^6 – or 5,000,000 – mechanical operations.

The most commonly used starter is the direct-on-line (d.o.l.) type where its three mains outgoing cables are connected directly to the motor terminals. Any restrictions demanding reduced voltage starting are discussed on page 63.

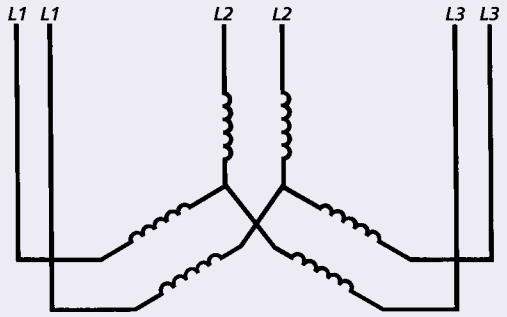
TYPE OF DUTY	TYPICAL APPLICATIONS	SUITABLE EATON MEM STARTER	MANUAL OR CONTACTOR STARTER
Intermittent starting of 3-phase motors to 7.5kW, 415V AC (Max. f.l.c. 16A)	Local control, infrequent operation. Small machines for DIY, workshops etc.	-	Manual
Frequent starting of 3-phase motors to 15kW d.o.l. 30kW star-delta 380/415V AC (Max. f.l.c. 57A)	Local or remote control of all kinds of machinery, pumps, fans, etc.	ADS7	Contactor
Frequent starting of 3-phase motors to 90kW, 380/550V AC (Max. f.l.c. 180A)	Local or remote control of larger motors, all kinds of machinery, pumps, fans, etc.	ADS7	Contactor

In addition to the conventional d.o.l. surface-mounting pattern of contactor starter, the ADS7 range incorporates variants which cater for specific requirements. The **flush mounting starter** is designed to fit into a suitably-sized recess to give a minimum projection control point for machinery. **Two-direction and reversing starters** incorporate two contactors enabling the direction of motor rotation to be changed. For Two-direction with intermediate stop the AC-3 rating is applicable whereas for rapid reversal without intermediate stop the AC4 rating is applied. Two direction starters are suitable for such applications as roller-shutter doors and small hoists. **Starter-isolator starters** incorporate a built-in, padlockable switch disconnector providing isolation facilities within a single compact unit.

Two-speed starters may be required for equipment designed to operate at more than one fixed speed, e.g. mixers, fans, certain machine tools. Two-speed starters are of two types: to control either dual-wound motors or tapped-wound (alternatively known as pole change) motors including PAM type.

Dual-wound motors have six or twelve terminals and two sets of stator windings. They are in effect two motors in one, each of equal power, and can be designed to deliver any two speeds from the normal motor r.p.m. range. Although usually arranged for direct-on-line, they can be star-delta operated. Starters for dual-wound motors incorporate two contactors and two overload relays to cater for the two sets of stator windings.

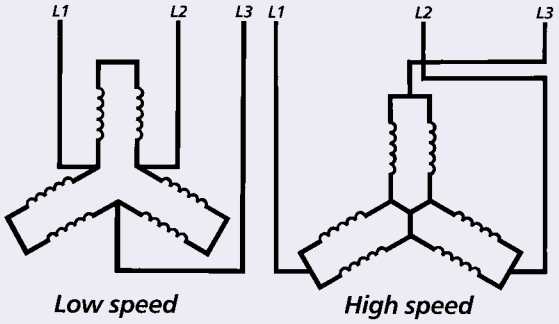
DUAL-WOUND MOTOR



Tapped-wound or pole change motors have six terminals. They use the principle that induction motor speed at a given frequency is determined by the number of pairs of stator poles fitted. Motor speed is thus varied by switching in or out an equal number of stator poles to give 2 or 4, 4 or 8, 6 or 12 poles and so on.

The higher speed is always twice that of the lower with this arrangement. Starters for tapped wound motors incorporate three contactors plus two overload relays, one for each speed.

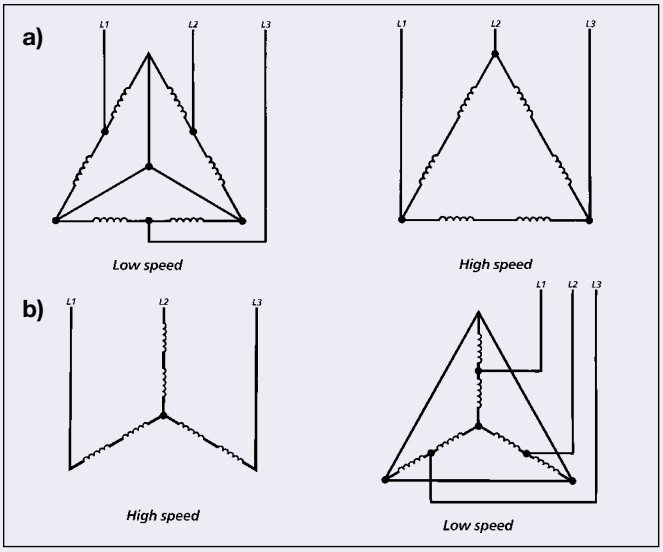
TAPPED WOUND MOTOR



Selecting the Correct Motor Starter

Single-phase or Three-phase?

PAM (pole amplitude modulated) motors are a form of pole-change motor specifically designed for close ratio two-speed operation. Tapped windings are connected either a) parallel star/series delta or b) parallel star/series star.



ADS7 starters suitable for either form of 2-speed operation are produced to order by Eaton MEMs Specials Department. When specifying, supply the usual kW and f.l.c. information, but ensure that this is given for **both** operating speeds.

The approximate no-load motor speed can be determined by using the formula:

$$N = \frac{60F}{P}$$

N = Synchronous speed (theoretical speed of motor with no load and no losses).

F = Frequency (Hz).

P = Number of pairs of stator poles.

Approx motor speeds based on formula

No of poles	*Rpm at 50Hz*
2	*3000*
4	*1500*
6	*1000*
8	*750*
10	*600*
12	*500*
16	*375*

Example

Synchronous speed of 4-pole 50Hz motor

$= \frac{60 \times 50}{2} = \frac{3000}{2} = 1500$ *rpm*

Note: Induction motors will run at approximately 3-5% below the synchronous speed, known as 'slip', according to motor design.

B) REDUCED VOLTAGE STARTING.

The most common methods of starting a three-phase squirrel cage motor are direct-on-line and star-delta.

The starting current of a standard squirrel cage motor when switched directly on to the supply (direct-on-line is approximately 6 to 8 times full load current) may develop up to 150% full load torque. This method of starting is not always permissible, particularly on larger machines owing to the following:

a) Limitations of switching peaks by supply authority or back up circuit breaker.

b) Starting peak will cause volt drop which can result in overheating of motor and supply cables.

c) High starting torque can under certain load conditions cause excessive mechanical wear.

In these conditions reduced voltage starters must be used and the most common is the star-delta starter. This method of starting restricts the starting current to $^1/_3$ of direct switching i.e. 2 to 3 times FLC with a corresponding drop in the starting torque.

An alternative is the auto-transformer starter, which is normally used where a higher starting torque is required to accelerate the driver or the motor only has three terminals. The starting current and torque are determined by the auto-transformer tapping used.

The table below gives the appropriate starting current and torque likely to be obtained.

METHOD OF STARTING	STARTING CURRENT (% FLC)	STARTING TORQUE (%FLT)
Direct-on-line	**600/800**	**100/150**
Star-delta	**200/300**	**30/50**
Auto-transformer (according to tapping used)	**100/400**	**16/80**

C) LOCAL OR AUTOMATIC CONTROL?

Starters fitted with push buttons are used in applications which require **local** control of the motor by an operative, as in drilling machine or lathe. They may be manual or contactor, d.o.l. or star-delta, as appropriate, depending on the motor rating, frequency of switching operations involved and the local electricity supply authority regulations.

Automatic – usually '2 wire' – control is applied to motors which are required to operate automatically as conditions dictate, e.g. when the drive for a fan or compressor is activated by a thermostat or pressure switch.

All ADS7 starters are suitable for either local or automatic control. Overload relays are readily adjustable between HAND and AUTO/RESET via a simple knob control. In the case of 2-wire control, it is important to set to HAND reset.

Selecting the Correct Motor Starter

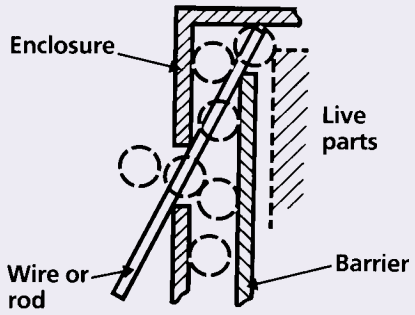
Enviromental Conditions and Fault Finding Checklist

WHAT ENVIRONMENTAL CONDITIONS APPLY?

You should ascertain the conditions which prevail where the starter is to be located, i.e. the level of dust in the atmosphere and the likelihood – if any – of contact with water.

The table defines International Protection (IP) ratings appropriate to various environmental conditions. ADS7 metal enclosure starters are rated IP54 which indicates protection against ingress of dust and splashing liquid from any direction. This ensures that the range is perfectly acceptable in the vast majority of applications. However, should a d.o.l. starter be required for a very dusty location (say, a flour mill) or one where sprayed water is frequently encountered (garden centre, green house, car wash), then an IP65 ADS7 moulded enclosure starter should be used.

With regard to ingress of solid foreign bodies indicated by the first characteristic numeral, BSEN 60529:1992 differentiates between protection of the equipment inside the enclosure and personal protection against contact with live parts. Thus IP3X indicates protection of enclosed equipment against ingress of a solid object greater than 2.5mm diameter or thickness; while IP3XD protects the person against contact by a 1mm diameter test probe no longer than 100mm although solid foreign bodies not exceeding 2.5mm diameter can still enter (see diagram).



The second characteristic numeral indicates the degree of protection of enclosed equipment with respect to harmful ingress of water. IP rating tables are given on page 69.

Coil voltage

Coils in Eaton MEM starters comprise contactor coils in the case of automatic starters; and no-volt release coils where these are fitted to manual starters. Standard coils are usually rated either 220/240V or 380/415V, 50Hz. On 3-phase, 415V systems, the coil is usually connected between the supply lines. Therefore, a 380/415V coil is required. ADS7 380/415V coil starters are ready-wired in this way. Where other components in a more complex control scheme require use of a 240V coil, a 220/240V coil starter should be selected. In this case, the control circuit must be wired to ensure that the coil circuit operates between one phase and the neutral.

STARTERS LESS OVERLOADS

ADS7 starters are supplied without overload relays which should be selected separately to suit the application.

Selection of starter and appropriate overload (see page 65) is very simple and once again merely requires voltage, f.l.c. and kw rating to be established from the motor rating plate.

Ideally an overload relay should be selected whose current scale corresponds at its upper end with the motor f.l.c. It can thus be adjusted downwards to the motor's running current if this is known. However, adequate protection is obtained if the overload relay's scale pointer is set to the motor f.l.c.

FAULT FINDING CHECKLIST

Experience has shown that complaints about starter malfunction usually stem from incorrect installation or the easily-rectified results of rough handling, transit shock, etc. A selection of the most frequently encountered symptoms and their remedies is given below. It is assumed that testing will be carried out by a competent electrician.

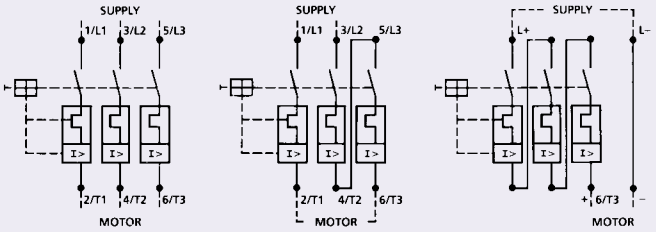
PROBLEM	LIKELY CAUSE	REMEDY
Newly-installed starter will not function.	a) overload disturbed in transit and in tripped position. b) Control wiring incorrect/ incomplete. c) Open circuit on one phase.	Press STOP/RESET button. Check circuit. Ensure all phases are live on incoming and motor terminals.
Coil overheating.	Wrong coil fitted (eg, 220/240V coil where should be 380/415V or vice versa. See note opposite).	Change coil to correct type.
Overload relay trips during starting.	a) Overload relays set too far below f.l.c. b) Motor taking too long to accelerate to full speed. c) Incorrectly wired main circuit particularly common in single-phase applications.	Adjust overload relay setting. Check motor is adequately rated for driven load. Check volt drop on supply is within recommended limits. Wire in accordance with appropriate diagram on page 65. (Because the overload relay is phase-failure sensitive for additional motor protection in the case of phase loss it is always necessary to include all 3 poles in the main circuit).

*Where possible, select current range to correspond with the motor nameplate rating. kW and hp figures are typical only and may not apply to all types of motor.

Selecting the Correct Motor Starter

Fault finding Checklist and Selection of Overload Relays

TYPICAL DIAGRAMS FOR 3-PHASE, SINGLE-PHASE AND DC OPERATION.



3-phase Single-phase D.C.

PROBLEM	LIKELY CAUSE	REMEDY
Noisy or overheated contactor.	a) Intermittent contact in control circuit. b) Dusty magnet faces owing to pollution by foreign bodies during installation.	Check all auxiliary contacts and remote switches for effective contact. Clean magnet faces.
Excessive contact burning or welding.	a) Excessive voltage drop causing magnet to unseat. b) Intermittent contact in control circuit causing contactor to chatter. c) Contactor making or breaking on severe fault.	Check supply voltage is within recommended limit. Check all auxiliary contacts and switches for effective contact. Check co-ordination of main fuse or MCB (see page 10).
Unable successfully to connect pressure switch into control circuit.	Confusion over correct control circuit to be used.	Consult starter instruction leaflet or Eaton MEM catalogue wiring diagram and use appropriate "REMOTE 2 - WIRE (SWITCH) CONTROL" circuit.
Further advice can be obtained from Eaton MEMs Technical Services Department, telephone number 0121-685 2001.		

SELECTION OF OVERLOAD RELAYS

(FOR THE FOLLOWING ADS7 STARTERS SUPPLIED WITHOUT)

DIRECT-ON-LINE	METALCLAD, IP54		METALCLAD WITH ISOLATOR, IP54		OVERLOAD RELAY			
MOTOR VOLTAGE	220/240V 50Hz COIL LIST NO.	380/415V 50Hz COIL LIST NO.	220/240V 50Hz COIL LIST NO.	380/415V 50Hz COIL LIST NO.	APPROX RATING KW	HP	*CURRENT RANGE	LIST NO.
380/415V 3-phase	27ADS1X	47ADS1X	27ADSA1X	47ADSA1X	0.07	1/12	0.15-0.22	TT114
					0.10	1/8	0.22-0.33	TT115
					0.12	1/6	0.33-0.50	TT116
					0.18	1/4	0.50-0.74	TT117
					0.37	1/2	0.75-1.11	TT87
					0.55	3/4	1.11-1.66	TT88
					1.10	1 1/2	1.66-2.50	TT89
					1.50	2	2.50-3.70	TT90
					2.50	3	3.70-5.60	TT91
					4.00	5 1/2	5.60-8.40	TT92
					5.50	7 1/2	8.40-11.90	TT93
					7.50	10	11.40-16.00	TT94
220/240V 1-phase	27ADS1X	–	27ADSA1X	–	0.07	1/12	0.74-1.11	TT87
					0.10	1/8	1.11-1.66	TT88
					0.12	/6	1.66-2.50	TT89
					0.37	1/2	2.50-3.70	TT90
					0.56	3/4	3.70-5.60	TT91
					0.75	1	5.60-8.40	TT92
					1.10	1 1/2	8.40-11.90	TT93
					2.20	3	11.40-16.00	TT94
380/415V 3-phase	27ADS2X	47ADS2X	27ADSA2X	47ADSA2X	11.00	15	16.00-23.00	TT104
220/240V 1-phase	27ADS2X	–	27ADSA2X	–	3.00	4	16.00-23.00	TT104

*Where possible, select current range to correspond with the motor nameplate rating. kW and hp figures are typical only and may not apply to all types of motor.

Selecting the Correct Motor Starter

Selection of Overload Relays

DIRECT-ON-LINE	METALCLAD, REVERSING IP54		MOULDED, IP65		OVERLOAD RELAY			
MOTOR VOLTAGE	220/240V 50Hz COIL LIST NO.	380/415V 50Hz COIL LIST NO.	220/240V 50Hz COIL LIST NO.	380/415V 50Hz COIL LIST NO.	APPROX RATING KW	HP	*CURRENT RANGE	LIST NO.
380/415V 3-phase	27ARD1X	47ARD1X	27ADSM1X	47ADSM1X	0.07	1/12	0.15-0.22	TT114
					0.10	1/8	0.22-0.33	TT115
					0.12	1/6	0.33-0.50	TT116
					0.18	1/4	0.50-0.74	TT117
					0.37	1/2	0.74-1.11	TT87
					0.55	3/4	1.11-1.66	TT88
					1.10	1 1/2	1.66-2.50	TT89
					1.50	2	2.50-3.70	TT90
					2.50	3	3.70-5.60	TT91
					4.00	5 1/2	5.60-8.40	TT92
					5.50	7 1/2	8.40-11.90	TT93
					7.50	10	11.40-16.00	TT94
220/240V 1-phase	27ARD1X	–	27ADSM1X	–	0.07	1/12	0.74-1.11	TT87
					0.10	1/8	1.11-1.66	TT88
					0.12	1/6	1.66-2.50	TT89
					0.37	1/2	2.50-3.70	TT90
					0.56	3/4	3.70-5.60	TT91
					0.75	1	5.60-8.40	TT92
					1.10	1 1/2	8.40-11.90	TT93
					2.20	3	11.40-16.00	TT94
380/415V 3-phase	27ARD2X	47ARD2X	27ADSM2X	47ADSM2X	11.00	15	16.00-23.00	TT104
220/240V 1-phase	27ARD2X	–	27ADSM2X	–	3.00	4	16.00-23.00	TT104
STAR-DELTA	METALCLAD, IP54,		METALCLAD, IP54		OVERLOAD RELAY			
MOTOR VOLTAGE	220/240V 50HZ COIL LIST NO.	380/415V 50HZ COIL LIST NO.	220/240V 50HZ COIL LIST NO.	380/415V 50HZ COIL LIST NO.	Approx RATING KW	HP	*CURRENT RANGE	LIST NO.
380/415V 3-phase	27SDA2X	47SDA2X	27SDA3X	47SDA3X	3.00	4	4.30-6.40	TT97
					5.00	6 1/2	6.40-9.70	TT98
					7.50	10	9.70-14.50	TT99
					10.00	13	14.50-20.60	TT100
					15.00	20	19.70-27.70	TT101
					22.00	30	26.00-38.00	TT102
					30.00	40	38.00-57.00	TT103

*Where possible, select current range to correspond with the motor nameplate rating. kW and hp figures are typical only and may not apply to all types of motor.

Selecting the Correct Motor Starter

Motor Full Load Current Table

AC MOTORS – FULL LOAD CURRENT TABLES (1450 RPM APPROX)

(Provided as a guide to the selection of suitable Eaton MEM control gear).

The tables are based on motors of approx. 1450 rpm of average efficiency and power factor. Motors of higher speed than 1450 rpm usually take a lower current than that shown in the table; while motors of lower speed usually take higher current.

Wide variations from these figures can arise, especially on single phase motors and engineers should, whenever possible, determine the actual f.l.c. from the motor rating plate in each case.

MOTOR RATING

SINGLE-PHASE MOTORS APPROX F.L.C. LINE VOLTAGE

kW	hp	110V	220V	240V
0.07	1/12	2.4	1.2	1.1
0.1	1/8	3.3	1.6	1.5
0.12	1/6	3.8	1.9	1.7
0.18	1/4	4.5	2.3	2.1
0.25	1/3	5.8	2.9	2.6
0.37	1/2	7.9	3.9	3.6
0.56	3/4	11	5.5	5
0.75	1	15	7.3	6.7
1.1	1.5	21	10	9
1.5	2	26	13	12
2.2	3	37	19	17
3	4	49	24	22
3.7	5	54	27	25
4	5.5	60	30	27
5.5	7.5	85	41	38
7.5	10	110	55	50

MOTOR RATING

THREE-PHASE MOTORS APPROX F.L.C. LINE VOLTAGE

kW	hp	220V	240V	380V	415V	550V
0.07	1/12	–	–	–	–	–
0.1	1/8	0.7	0.6	0.4	0.4	0.3
0.12	1/6	1	0.9	0.5	0.5	0.3
0.18	1/4	1.3	1.2	0.8	0.7	0.4
0.25	1/3	1.6	1.5	0.9	0.9	0.6
0.37	1/2	2.5	2.3	1.4	1.3	0.8
0.56	3/4	3.1	2.8	1.8	1.6	1.1
0.75	1	3.5	3.2	2	1.8	1.4
1.1	1.5	5	4.5	2.8	2.6	1.9
1.5	2	6.4	5.8	3.7	3.4	2.6
2.2	3	9.5	8.7	5.5	5	3.5
3	4	12	11	7	6.5	4.7
3.7	5	15	13	8	8	6
4	5.5	16	14	9	8	6
5.5	7.5	20	19	12	11	8
7.5	10	27	25	16	15	11
9.3	12.5	34	32	20	18	14
10	13.5	37	34	22	20	15
11	15	41	37	23	22	16
15	20	64	50	31	28	21
18.5	25	67	62	39	36	26
22	30	74	70	43	39	30
30	40	99	91	57	52	41
37	50	130	119	75	69	50
45	60	147	136	86	79	59
55	75	183	166	105	96	72
75	100	239	219	138	125	95
90	125	301	269	170	156	117
110	150	350	325	205	189	142
130	175	410	389	245	224	169
150	200	505	440	278	255	192
160	220	520	475	300	275	207
185	250	600	550	347	318	240
200	270	640	586	370	339	255
220	300	710	650	408	374	282
250	335	–	–	465	430	325
300	400	–	–	545	505	385

Selecting the Correct Motor Starter

Short Circuit Co-ordination

SHORT CIRCUIT CO-ORDINATION

The back up fuses quoted in this publication give Type 2 co-ordination (as defined in BSEN 60947-4-1) such that after an extremely heavy short circuit the risk of welded contacts is accepted but the starter must be suitable for further service after the weld has been broken.

In selected cases it is possible to use Memshield 2 miniature circuit breakers to provide similar back up protection for automatic starters.

STARTER TYPE	OVERLOAD RELAY CURRENT RANGE (A)	BACK-UP PROTECTION MAX. HRC FUSE, EATON MEM 'S' TYPE (A)	MEMSHIELD 2 MCBS TYPE C	MEMSHIELD 2 MCBS TYPE D
ADS7 Direct-on-line. 380/415V 3-phase	0.15-0.22	2	MCH306	MDH306
	0.22-0.33	2	MCH306	MDH306
	0.33-0.50	2	MCH306	MDH306
	0.50-0.74	4	MCH306	MDH306
	0.74-1.11	6	MCH306	MDH306
	1.11-1.66	6	MCH306	MDH306
	1.66-2.50	10	MCH306	MDH306
	2.50-3.70	16	MCH310	MDH306
	3.70-5.60	20	MCH316	MDH310
	5.60-8.40	20M25	MCH320	MDH316
	8.40-11.90	20M32	MCH320	MDH320
	11.40-16.00	32M40	MCH340	MDH332
	16.00-23.00	32M50	MCH340	MDH332
	22.00-33.00	63M80	MCH363	MDH340
Direct-on-line, 220/240V single phase	0.74-1.11	6	MCH106	MDH106
	1.11-1.66	6	MCH106	MDH106
	1.66-2.50	10	MCH110	MDH106
	2.50-3.70	16	MCH110	MDH106
	3.70-5.60	20	MCH116	MDH110
	5.60-8.40	20M25	MCH120	MDH116
	8.40-11.90	20M32	MCH132	MDH120
	11.40-16.00	32M40	MCH150	MDH132
Star-Delta. 380/415V 3-phase	4.30-6.40	16	MCH310	MDH310
	6.40-9.70	20	MCH316	MDH316
	9.70-14.50	20M25	MCH320	MDH320
	14.50-20.60	20M32	MCH340	MDH332
	19.70-27.70	32M40	MCH350	MDH332
	26.00-38.00	32M63	MCH363	–
	38.00-57.00	63M80	–	–

Current range must be selected to include actual motor rated full load current.

STARTER TYPE	STARTER SIZE	BACK-UP PROTECTION MAX. HRC FUSE, EATON MEM 'S' TYPE, (A)
Heavy duty contactor starters. Direct-on-line 380/550V 3-phase	22DSB	63M100
	30DSB	100M160
	37DSB	100M160
	55DSB	200
	90DSB	250
Heavy duty contactor starters. Star-delta 380/550V 3-phase	30YSB	63M100
	45YSB	63M100
	55YSB	100M160
	75YSB	100M160
	90YSB	200

Eaton MEM can provide type 2 co-ordination data for Eaton MEM fuses and other manufacturers motor starter combinations in accordance with the latest IEC recommendations.

Degrees of Protection, IP Ratings

The degrees of protection against ingress of foreign bodies and liquids are indicated by the first two characteristic numerals as detailed in tables 1 and 2. For switch and control gear the classification is recognised internationally and is described in detail in BSEN60529.

FIRST NUMBER **Protection against solid foreign objects** **IP**	**Requirements**	**Meaning protection of persons against access to hazardous parts with:**
0	No protection.	non-protected
1	Full penetration of 50mm diameter sphere not allowed. Contact with hazardous parts not permitted.	back of hand
2	Full penetration of 12.5mm diameter sphere not allowed. The jointed test finger shall have adequate clearance from hazardous parts.	finger
3	The access probe of 2.5mm diameter shall not penetrate.	tool
4	The access probe of 1.0mm diameter shall not penetrate.	wire
5	Limited ingress of dust permitted (no harmful deposit).	wire
6	Totally protected against ingress of dust.	wire
SECOND NUMBER **Protection against harmfull ingress of water** **IP**	**Requirements**	**Meaning protection from water**
0	No protection.	non-protected
1	Protected against vertically falling drops of water - limited ingress permitted.	vertically dripping
2	Protected against vertically falling drops of water with enclosure tilted 15° from the vertical - limited ingress permitted.	dripping up to 15° from the vertical
3	Protected against sprays to 60° from the vertical – limited ingress permitted.	limited spraying
4	Protected against water splashed from all directions – limited ingress permitted.	splashing from all directions
5	Protected against low pressure jets of water from all directions – limited ingress permitted.	hosing jets from all directions
6	Protected against strong jets of water – limited ingress permitted	strong hosing jets from all directions.
7	Protected against the effects of immersion between 15cm and 1m.	temporary immersion
8	Protected against long periods of immersion under pressure.	continuous immersion
ADDITIONAL LETTER **(Optional)** **IP**	**Requirements**	**Meaning protection of persons against access to hazardous parts with:**
A For use with O	Penetration of 50mm diameter sphere up to guard face must not contact hazardous parts.	back of hand
B For use with 0 & 1	Test finger penetration to a maximum of 80mm must not contact hazardous parts.	finger
C For use with 1 & 2	Wire of 2.5mm diameter x 100mm long must not contact hazardous parts when spherical stop face is partially entered.	tool
D For use with 1, 2 & 3	Wire of 1.0mm diameter x 100mm long must not contact hazardous parts when spherical stop face is partially entered.	wire
		Limited penetration allowed with all four additional letters

UK MANUFACTURING

INDUSTRIAL SWITCHGEAR, CONTROL GEAR, CIRCUIT BREAKER SYSTEMS AND BUSBAR TRUNKING:

MEM Circuit Protection & Control
Reddings Lane,
Birmingham B11 3EZ
Tel: 0121 685 2100
Fax: 0121 706 2012
Busbar Trunking
Tel: 0121 707 9797
Fax: 0121 707 4840

TOTAL PROJECT MANAGEMENT, MV & LV SWITCHBOARDS, PFC & TVSS:

MEM Circuit Protection & Control
Premier Street, Birmingham B7 5TQ
Tel: 0121 326 2500
Fax: 0121 327 0656
Fax: Estimation: 0121 326 2541
Fax: Project Management:
0121 326 2567

ELECTRICAL ACCESSORIES AND DOMESTIC SWITCHGEAR:

MEM 250
Whitegate, Broadway,
Chadderton, Oldham,
Lancs. OL9 9QG
Tel: 0161 652 1111
Fax: 0161 626 1709

UK REGIONAL SALES OFFICES

South East Regional Sales Office
Suite 8
Ensign House
Admiral's Way
London E14 9XQ
Tel: 0207 987 8602
Fax: 0207 987 4632

South West, Midlands,
North & Scotland Sales Office
Reddings Lane
Tyseley
Birmingham B11 3EZ
Tel: 0121 685 2155
Fax: 0121 685 2191

INTERNATIONAL LOCATIONS

Eaton Electric Switchgear Sdn. Bhd
PO Box 162,
12720 Butterworth,
Seberang Perai, Malaysia
Tel: (60) 4 3907566
Fax: (60) 4 3990746

Bell - A Division of
Eaton Electric Systems Pty Ltd
10 Kent Road, Mascot,
NSW 2020, Australia
Tel: (61) 2 9693 9333
Fax: (61) 2 9693 1258

Eaton Electric Ltd
PO Box 30838, Dubai,
United Arab Emirates
Tel: (971) 4 2660187
Fax: (971) 4 2693774

Eaton Holec
PO Box 23,
7550 AA Hengelo
The Netherlands
Tel: (31) 74 246 9111
Fax: (31) 74 246 4444

Eaton Electric Switchgear (Asia Pacific) Pte Ltd
50 Genting Lane #03-05,
Cideco Industrial Complex,
Singapore 349558
Tel: (65) 67410737
Fax: (65) 67410738

Eaton Electric Company Ltd
595 Pracha-Uthit Road,
(Ramkhamhaeng 39)
Wangthonglang Bangkok,
10310, Thailand
Tel: (66) 2 935 6470
Fax: (66) 2 935 6478

Eaton Electric Ltd
PO Box 1993
Doha, Qatar
Tel: (974) 4654792
Fax: (974) 4654792

Eaton Innovative Technology
15470 Flight Path Drive,
Brooksville,
Florida 34604, USA
Tel: 001 352 799 0713
Fax: 001 352 796 0316

Eaton Electric & Engineering Services Ltd
6th Floor, Mtl Warehouse,
Phase 11 Berth One,
Kwai Chung Container Terminal
Kwai Chung, N.T. Hong Kong
Tel: (852) 2942 4388
Fax: (852) 2615 2289

Eaton Electric Ltd
East African Regional Office
1st Floor, Liaison House,
State House Avenue,
PO Box 48010,
Nairobi, Kenya
Tel: (254 2) 2719230/2718859
Fax: (254 2) 2711969

Eaton Elek
AM Alten Bach 18,
41470 Neuss,
Germany
Tel: (49) 21 37 7810
Fax: (49) 21 37 781152

MEM Circuit Protection & Control
Eaton Electric Limited
Reddings Lane
Birmingham B11 3EZ
Tel: 0121 685 2100
Fax: 0121 706 2012
Sales Support 0121-685 2000
Technical Support 0121-685 2001
Fax for Orders & Sales Enquiries 0121-706 9996
Central Quotation Service: 0121 326 2541
Email: meminfo@eaton.com
www.memonline.com

EATON | MEM

CAT 865/06/03